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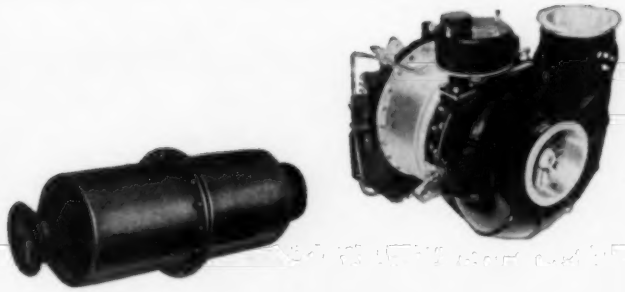

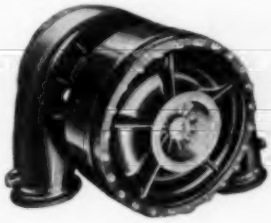

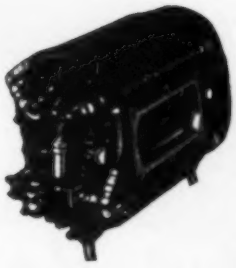

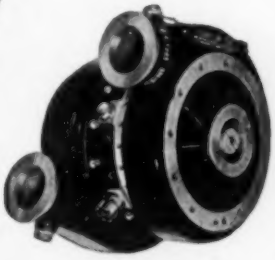

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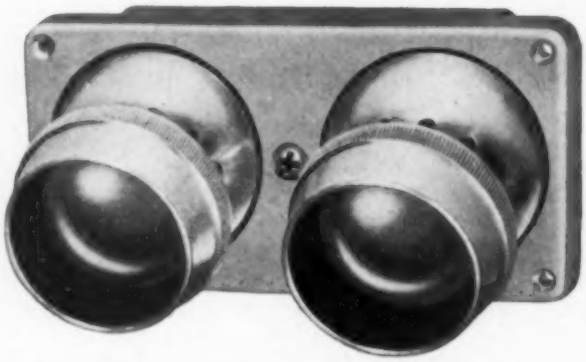

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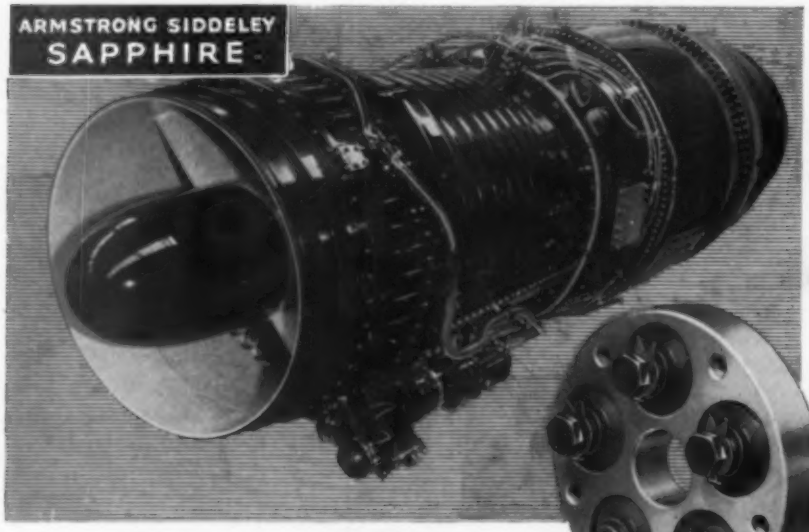

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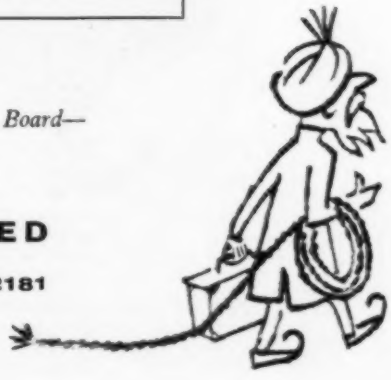

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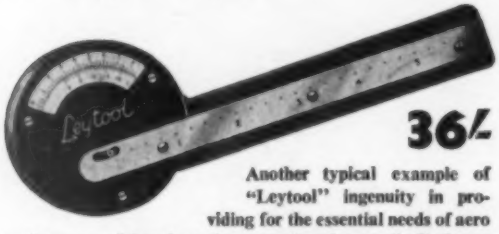

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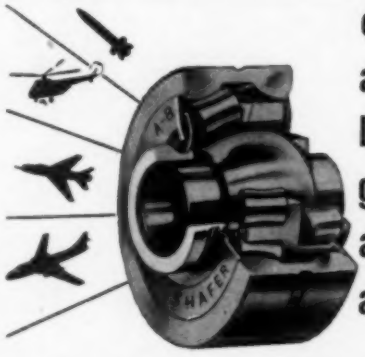

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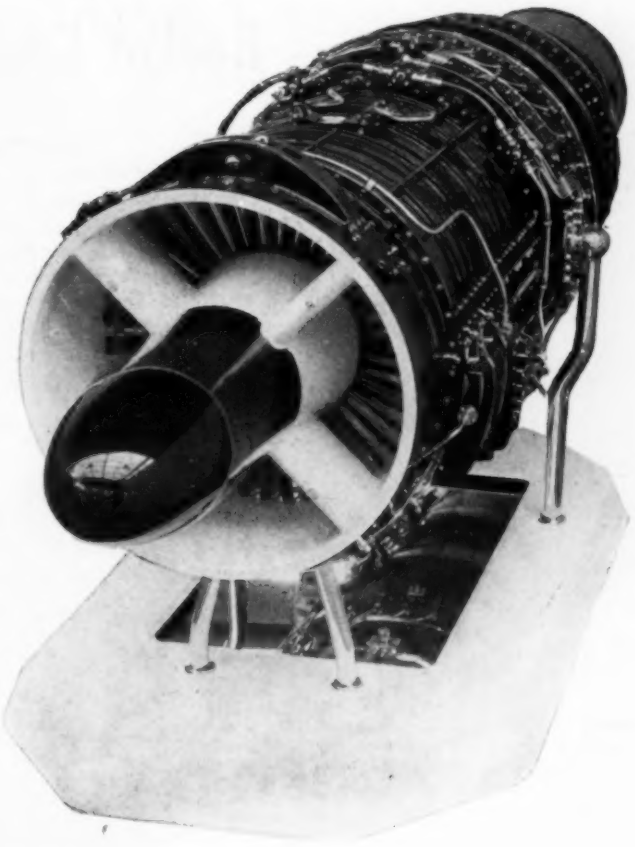

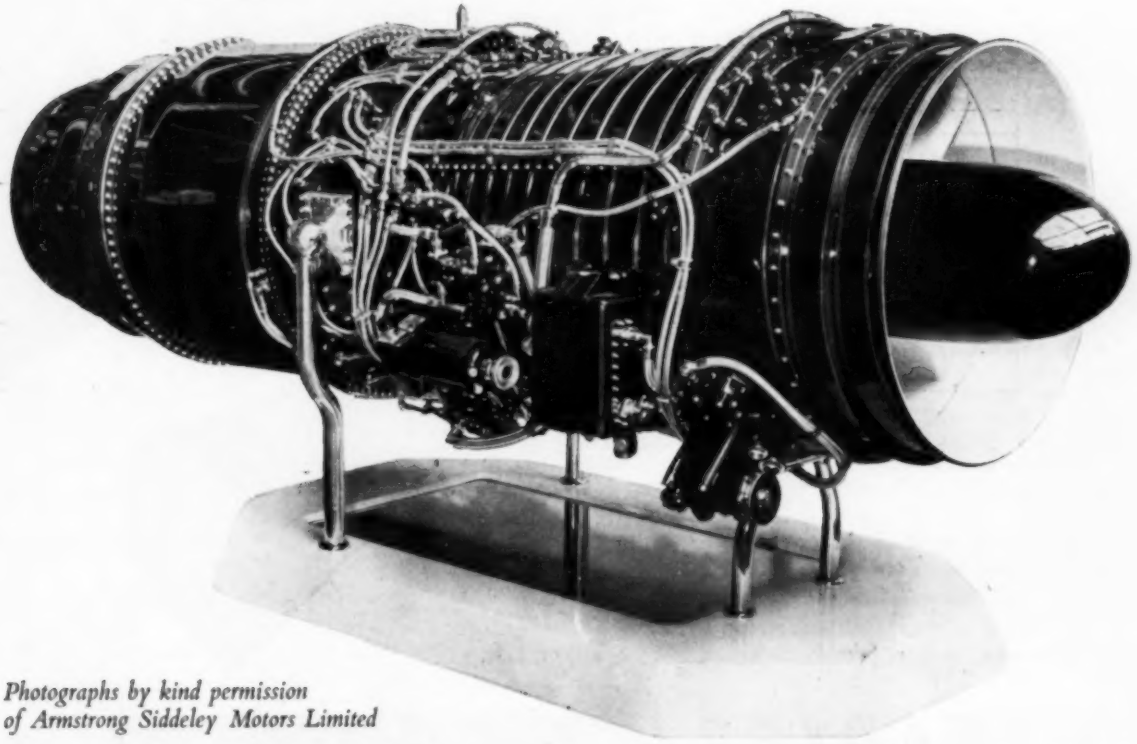

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FIRST AERONAUTICAL WEEKLY IN THE WORLD FOUNDED 1909

FLIGHT
and
AIRCRAFT ENGINEER

No 2494 Vol 70 FRIDAY 9 NOVEMBER 1956

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"Not as a Scythe . . ."

OUT of the storm of indignation and emotion that followed Britain's action against Egypt, and sometimes obscured the political and moral issues involved, a plain fact emerged: that the modern air weapon—in this instance comprising shore- and carrier-based elements of the British and French Services—can, by the very speed and precision of its operations, go far to achieving the aim of a campaign with a minimal loss of time and of life. Within hours, almost, the Egyptian Air Force had been largely neutralized. Her Army's equipment had been heavily damaged and installations had been knocked out.

The pattern of attack was a classic, with Valiants and Canberras bombing by night from medium level, using radar and pathfinder techniques, to ensure that opposing fighters should be grounded during the succeeding daylight attacks by fighter/bombers and strike aircraft. "A very high degree of accuracy" is officially claimed to have been achieved, and not the least gratifying aspect of this was that the loss of Egyptian life was, so far as can be gathered, very small.

The air weapon is in all truth a very terrible one. But the opening phases of this grave and bitterly controversial operation have shown what can be accomplished when that weapon is handled as a rapier and not as a scythe.

As this is written the airborne assault is under way. In this type of operation large bodies of men may be opposing each other at close quarters over relatively long periods and casualties could be heavy on both sides. But in this phase once again we have sought to spare the Egyptian people, for there has been no preliminary bombardment of the target area. Early reports show that the Hastings, the Valettas and the French Noratlases have returned without loss, their way having been cleared by fighter-bomber attacks on flak posts and similar targets.

Grave and contentious as the Egyptian issue is, we can at least take pride that, insofar as lives could be spared, the air forces of Great Britain and France have, through their sheer effectiveness, been able to meet the earnest injunctions placed upon them.

Oil or Neutrons?

THAT these islands are utterly dependent upon imported petroleum is a fact we are inclined to overlook until events such as those of recent weeks drive the truth forcibly home. Even so, there seems to be a general belief that, provided the world's shipping routes are kept open, and that not too many pipelines are cut or wells closed down, we shall never be starved of our life-blood of crude petroleum.

This belief may, or may not, be justified; but the publication in this issue of an abstract of a paper, by a British engineer, on the application of nuclear power to the propulsion of aircraft is unquestionably pertinent. Although few in this country have yet devoted much real thought to the subject it is clearly one which should by now be the full-time concern of an appreciable proportion of our aircraft industry. Practically nothing has so far been said of our work in this field.

American policy is in striking contrast. A writer in one of our transatlantic contemporaries recently reported that:—

"Weapons System 125A is a bomber with supersonic dash performance, powered by the terrible energy that has devastated two cities, vaporized a fleet and swallowed an island . . . Two parallel programmes are under way on 125A, with a possible third in the offing. Convair . . . is teamed with General Electric on one concept. A second kind of powerplant plus airplane is being worked out by Lockheed . . . and Pratt and Whitney. The WS-125A bomber system is closer to reality than is generally realized. Many of its subsystems and components have been built and tested in the peculiar environment in which they will work. The list of tangible accomplishments is a formidable one. . . ." [*The report goes on to give the list.*]

No one could expect Britain to support a programme equivalent to either half of the WS-125A project. But it is heartening to note that few members of our industry still appear to regard the nuclear-powered aeroplane as a nebulous dream of the future. Indifference could lead to unpleasant surprises.

FROM ALL QUARTERS

Air Operations Against Egypt

AT 4.30 a.m. G.M.T. on October 31, the British and French ultimatum to Egypt expired; and at 4.30 p.m. that day the first news of military operations against Egypt was given in a communiqué from Allied Forces Headquarters in Nicosia, which disclosed that an offensive by bomber aircraft had been launched against military targets in Egypt. A second communiqué said that these targets were airfields near Cairo (Almaza and Inchas) and in the Canal Zone (the former R.A.F. stations Abu Sueir and Kabrit). According to the crews of the aircraft engaged, Canberras and Valiants, only light opposition was encountered, in the form of "inaccurate" anti-aircraft fire. The Air Ministry said the bombs dropped were of "the conventional high-explosive type."

Also on October 31, the Canadian Government suspended all arms shipments destined for Israel, including 24 F-86s, the sale of which had been announced by Mr. St. Laurent on September 21; on the following day the Jordan Government informed Britain that it would not allow the R.A.F. to use Jordan air bases against Egypt, and during an action in Lake Timsah an Egyptian blockship was attacked and sunk by Fleet Air Arm aircraft.

In the fighting between Israel and Egypt, the Egyptian frigate *Ibrahim Awal*, formerly the British destroyer *Cottesmore*, surrendered outside Haifa after an attack on her by Israeli rocket-firing aircraft, and was towed into harbour on October 31. The Israelis claimed that in air fighting three Egyptian Vampires and four Mig-15s had been shot down, with one Israeli aircraft damaged.

The Air Ministry announced on November 1 that R.A.F. operations in the Eastern Mediterranean were under the direction of Air Marshal H. L. Patch, Commander-in-Chief of the Middle East Air Force; and that the air task force commander is Air Marshal D. H. F. Barnett, who formerly commanded No. 205 Group in the Canal Zone, and was senior British liaison officer at U.N. military headquarters in Japan during the Korean war.

An attack by Valiants on Cairo West airfield, where some of Egypt's Il-28s are based, was cancelled on October 31 when some of the Valiants were already in the air, because American civilians were being evacuated from Cairo along an adjoining road. A Valiant was intercepted by an Egyptian Meteor N.F.13, which fired at but did not damage it.

Early on November 2 the Ministry of Defence issued a communiqué from Allied Forces Headquarters, stating that it was believed over 50 Egyptian aircraft had been destroyed during air attacks by land- and carrier-based aircraft—aimed at "neutralizing the Egyptian Air Force"—on nine airfields in the Nile Delta, and at least 40 others seriously damaged. No Allied losses had been reported.

At an Air Ministry press conference on November 2, a senior member of the Air Staff said that the first object of the air operations was "to take the sting out of the Egyptian Air Force" and it was thought the best method was first to pin it down by attacking its airfields and then to destroy it. Of bombing accuracy, he said one of the Government's firm injunctions had been to limit casualties and confine action to military targets; the degree of accuracy achieved had satisfied the C-in-C., otherwise he would not have continued to use the same technique—relatively low-level target-marker machines lighting up the target for the bombing aircraft—after the first night. Reconnaissance photographs of Kabrit and Inchas, taken that morning from 30,000ft, and handed round at the conference, showed many bomb craters on or near the runways.

The main lessons learned so far had been the "general flexibility" of air power; the accuracy obtained both by night and by day; and the relative minimum of casualties. Military targets only had been attacked, and no incendiary bombs used. There had been no casualties in the R.A.F. up to then; ground defences had been "slight" and the only interceptions by fighter aircraft were those mentioned in the communiqués.

Asked whether the "sting" had actually been taken out of the E.A.F., the spokesman answered that he did not know. He said the Air Ministry had quite a fair idea of the proportion of aircraft destroyed, but he could not say whether the E.A.F. had been "destroyed"; they did not have all the information that Cyprus had.

On the night of November 2, Valiants and Canberras from Malta attacked military barracks north-east of Cairo; the following day Luxor airfield was attacked and Allied headquarters in Nicosia then announced that the air offensive had "virtually destroyed" the Egyptian Air Force as a fighting force. The only Allied loss had been an R.A.F. Venom, and a Canberra had suffered minor damage by cannon fire from a Mig-15.

During last weekend, the scope of air operations against Egypt widened with attacks against radar installations, coastal and anti-aircraft batteries, marshalling yards, barracks and tanks. Military vehicles on roads in the Ismailia area were shot up; rockets and cannon were used against a concentration of tanks four miles south-west of the Giza pyramids near Cairo.

On Saturday, November 3, R.A.F. Hunters were employed for the first time in an offensive rôle when they escorted Canberras which bombed Huckstep military camp at Almaza.

A communiqué issued by Allied headquarters in Cyprus on November 5 said that photographic reconnaissance had established that a "high proportion" of the 100 or so Egyptian aircraft destroyed or damaged on the ground had been Mig fighters. Raiding aircraft had also "taken heavy toll" of Ilyushin bombers. A further communiqué said that operations by R.A.F. Valiant and Canberra aircraft, carrier-based Sea Hawks and French Thunderstreaks, Avengers and Corsairs "proceeded with undiminished intensity."

On the same day in London a Ministry of Defence spokesman said that British and French troops had parachuted on to Egyptian soil at Port Said that morning, the British troops from Hastings and Valetta aircraft and the French from Noratlas transports. Aircraft from the Allied carrier task force joined with R.A.F. Venoms and French Air Force Thunderstreaks in providing close support for the landing. Despite "a certain amount" of anti-aircraft fire, all the Valetta, Hastings and Noratlas aircraft returned safely from the operation.

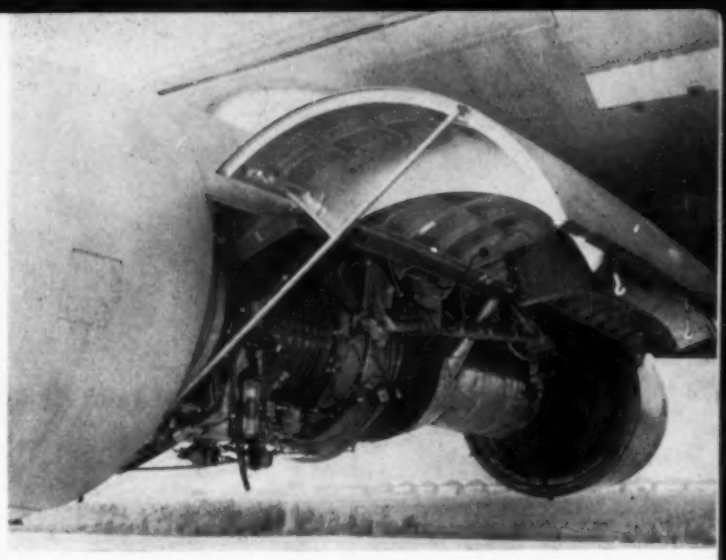
As one result of it, Gamil airfield, five miles west of Port Said, was captured; and later a French Dakota and a British helicopter landed to evacuate wounded. The French Air Ministry announced that photographic reconnaissance had confirmed the destruction by French fighters of eighteen Il-28s on Luxor airfield.

Neville Duke's Successor

FOLLOWING S/L. Neville Duke's recent retirement from high-speed test flying—a decision necessary on medical grounds, as a result of a flying accident last year—he is succeeded by his right-hand man, Mr. A. W. Bedford, as chief test pilot of Hawker Aircraft, Ltd. "Bill" Bedford, who is 35 years of age, has been the company's assistant chief test pilot for the past five years. Educated at Loughborough College, he served in the Royal Air Force for ten years, towards the end of which he took the Empire Test Pilots' School course, subsequently serving at the School as an instructor, and then as an R.A.E. test pilot. He now has some 4,500 hours in his log-book, 3,000 of which have been flown in single-engined aircraft. He is also a skilled glider pilot, holding the United Kingdom national distance and goal records with a 257-mile flight; he has also held the British altitude and distance records. A fortnight ago, flying the Hunter T.7 in company with Frank Murphy, he gained (subject to confirmation) out-and-home speed records between London and Rome.

A. W. Bedford.

***THE WYVERN STRIKES:** Good luck, or very smart work, enabled a Naval photographer to "stop" a pair of R.P.s, fired by a Westland Wyvern S.4, as they passed the characteristic Rotol contraprops of this carrier-borne strike aircraft. The Wyvern belongs to No. 830 Squadron, H.M.S. "Eagle," now operating in the Mediterranean.*



SNUG LITTLE GOD: A Bristol Orpheus installed for flight development in an Avro Ashton. Turbojets of this type (already developing well over 4,500 lb thrust and backed by more than 5,000 hours' running) have considerable air "experience" in the Folland Gnat and Fiat G.91.

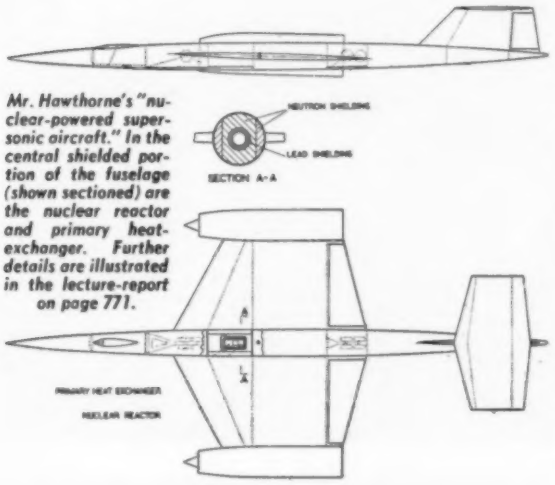
D.H. Acquire Interest in Saro

THE following announcement was issued from Hatfield last Monday evening: "De Havilland Holdings, Ltd., . . . have acquired an interest in Saunders-Roe, Ltd., of East Cowes.

"This association between the parent companies of two groups, each of whose activities cover a wide range of products, affords a valuable integration, the effect of which will be felt primarily in their marketing efforts, especially overseas."

Hawker Siddeley and Nuclear Power

FIRST news of the activities of the Hawker Siddeley Nuclear Power Co.—whose formation was announced early this year—was released last Monday. Work has begun on a study of the "liquid-metal fuel type of reactor." [In such a reactor the uranium is suspended in a solution of a metallic salt, e.g., uranyl sulphate.] The experimental programme will be carried through at the company's Langley, Bucks, establishment.



Mr. Hawthorne's "nuclear-powered supersonic aircraft." In the central shielded portion of the fuselage (shown sectioned) are the nuclear reactor and primary heat-exchanger. Further details are illustrated in the lecture-report on page 771.

Making the announcement, Sir Frank Spriggs, Hawker Siddeley Group managing director, disclosed also that one of the company's major activities will be "the development of advanced reactors for electricity generation." Mr. E. P. Hawthorne, chief executive (and a director) of the new subsidiary, added: "Although our membership of the Hawker Siddeley Group naturally implies an interest in the application of nuclear power to aircraft, this is certainly not our only objective. We foresee the applications of the lines of research we are now undertaking in the generation of electricity, including plants for remote areas such as may be required in the mining industry, for marine propulsion and for the production of process heat."

Clearly, however, the exploitation of nuclear-power possibilities for aircraft will be actively pursued. It was Mr. Hawthorne himself who, in a lecture to R.Ae.S. graduates and students last week, discussed these possibilities in some detail. The slides which illustrated the lecture included one—reproduced on this page—outlining the general arrangement of a nuclear-powered supersonic bomber. We summarize the lecture on page 771.

M.o.S. Appointments

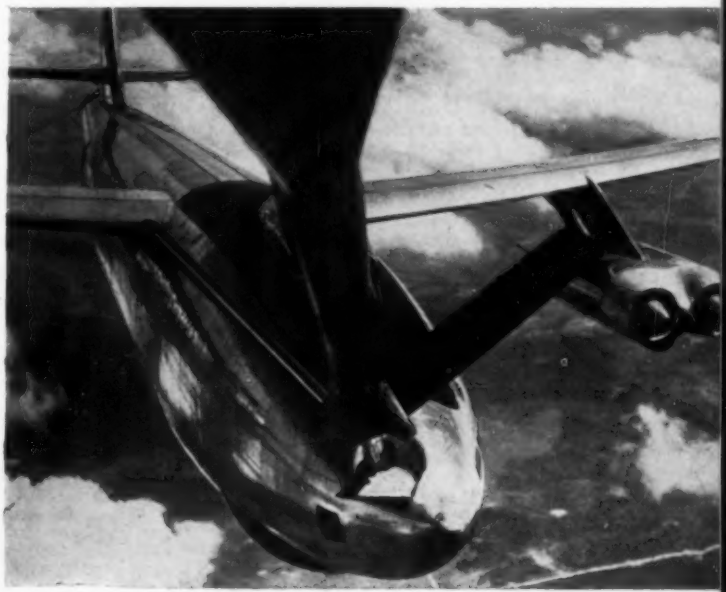
THREE senior appointments within the Ministry of Supply are announced. Dr. H. M. Wilson has been promoted to chief scientific officer and appointed Deputy Director-General of Aircraft Equipment Research and Development. In succession to Dr. Wilson, Dr. S. Jones has been made a deputy chief scientific officer and appointed Head of Armament Department, Royal Aircraft Establishment, Farnborough. Mr. N. Coles has been promoted to deputy chief scientific officer and appointed Deputy Director, Air Armament Research and Development.

Skeeter Development Described

DETAILS of the techniques employed by the helicopter engineering team at Saunders-Roe in the development of the Skeeter were described at last Friday's meeting of the Helicopter Association by Mr. T. D. Nisbet, A.F.R.Ae.S., who has been in charge of the flight research and ground testing programme for the machine. The lecturer covered a wide field, including most of the ground test-rigs which had been devised by the company and the methods used to refuel the rotor-head tank with high-test peroxide in the latest Skeeter type with rocket boosters at the blade tips.

Of especial interest was the series of experiments undertaken to determine the cause of the ground-resonance characteristics from which the machine had suffered in its early stages of development. Movement of the machine on the ground was partially restrained by a system of holding-down ropes and resonance was induced by "stirring" the control column, thereby causing the machine to bounce on its undercarriage. A film shown after the lecture included several sequences depicting the conduct of these experiments. The cause of the trouble was eventually detected, and rectified by means of modifications to the undercarriage and rotor head mechanism. The machine has now successfully passed its type test at Boscombe Down and is in production for observation duties with the Army.

Other film sequences showed the operation of the Saunders-Roe rotor test tower and the landing-gear drop-test rig. Tests with the rocket booster installation were also shown. To determine the efficacy of the pilot-operated h.t.p. fuel-flow switch on the rotor head, the hemispherical tank was filled with distilled water. Then, with the rotor spinning at take off r.p.m. on the ground, the pilot pressed the contacter switch in the cockpit and a shower of water was seen to cascade over the tarmac.



SHARK BAIT: Like a hooked shark is this Boeing B-47 six-jet bomber, being refuelled, by the "flying boom" method, from a Boeing KC-97 tanker. The picture was secured from the "pod" from which the refuelling boom is directed by means of the small wings.

HEAVY LOADS LET DOWN LIGHTLY

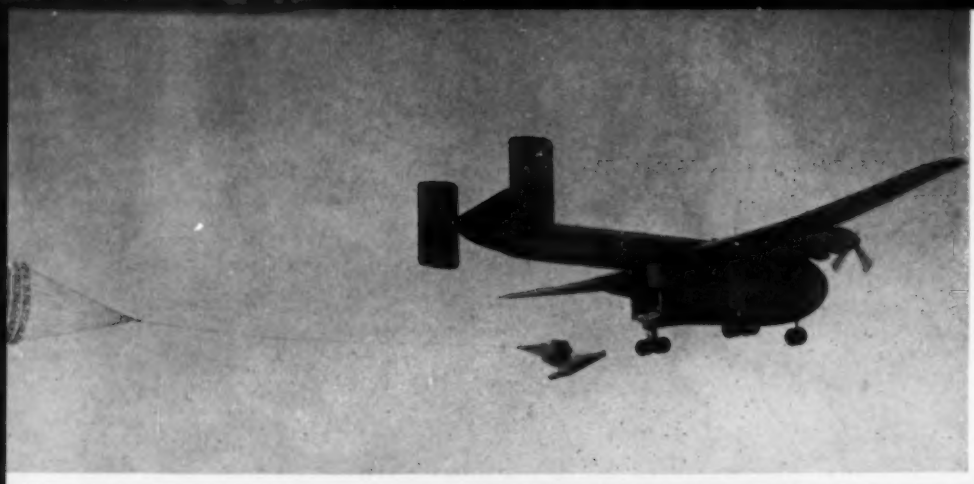
—by Parachute from Two Big Transports: Dropping Tests by Hercules and Beverley

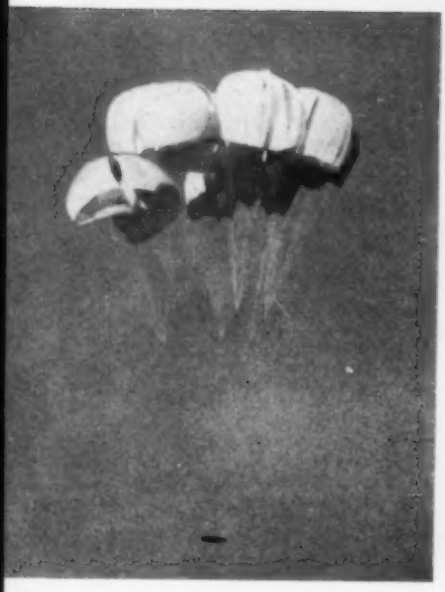
Scenes during the C-130's U.S.A.F. service tests at Pope A.F.B.: (Top) A Marine recoilless-rifle carrier being loaded from trailer-bed; (centre) A two-and-half-ton truck is drawn out of the hold by the extractor parachute; (bottom) the same truck floating down under its six cargo parachutes. The C-130's cargo doors can be opened in flight.

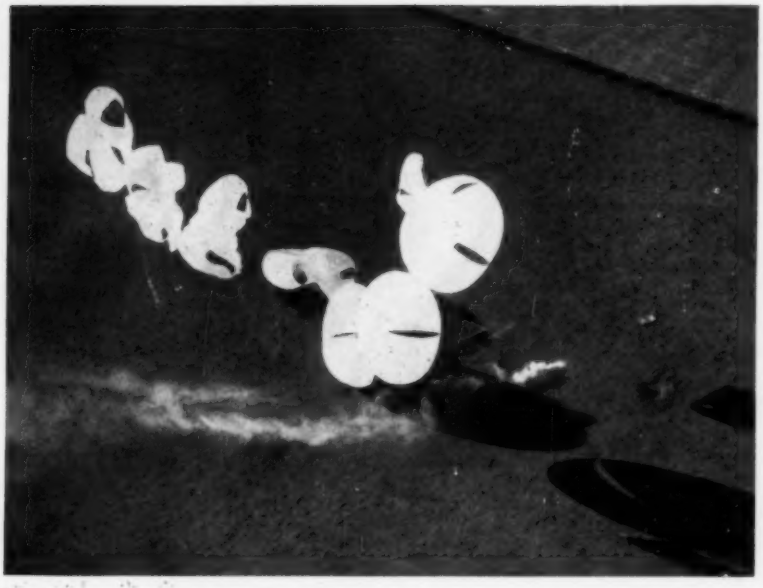
HEAVY test-loads of iron and large items of equipment have been dropped by parachute recently from both a Blackburn Beverley and a Lockheed C-130 Hercules. During a parachute research programme at Brough, the Beverley parachuted a 24,000-lb load of steel plates and angle iron, the heaviest single item ever dropped from the air in this country. It is noteworthy that this 10¾-ton weight represents less than half the Beverley's payload.

The Lockheed C-130 recently flew a programme of 86 sorties from Pope A.F.B., North Carolina, during which it dropped a total of 160 tons of supplies, 485 paratroopers and 315 dummies. Earlier this year, at El Centro, California, it released the world's record single load of 27,000 lb of iron.

The Beverley's load was eased down to the ground at a rate of 24 ft/sec by eight of the latest G.Q. segmented cargo parachutes. These each have a flying diameter of 66ft and contain almost 1,000 yd of nylon and 96 rigging lines, each 90ft long. The aircraft made the drop when flying at 130 kt, the last part of the run-up being directed by the supply-aimer in the nose. A 14ft extractor parachute, mounted on the rear sill of the freight floor, was first released, to draw the load pallet along the roller conveyor and out into the airstream. As the load left the aircraft a static line transferred the pull from the pallet to the main parachutes and the extractor began to draw these canopies from their bags. This sequence was so arranged that initially only four feet of the canopies deployed, thus limiting the opening shock. When the load reached the ground the main canopies were automatically detached to prevent dragging. The extractor lowered the main canopy containers independently to the ground. The designed touch-down rate of descent, 24ft/sec, is that of a paratrooper.







Three phases in the dropping of 24,000 lb of steel and iron ballast from the Beverley at Brough. At left, the 14ft extractor has pulled the load out of the hold and the parachute containers are being drawn clear. Below, left and right, the eight 66ft G.Q. parachutes are deploying and five of them detach themselves cleanly after landing near the marker.

In North Carolina, the C-130 was evaluated by the 3245th Test Group (Bombardment) from Eglin A.F.B. and the Continental Army Command Board Five from Fort Bragg, with the assistance of the U.S.A.F.'s 3rd Aerial Port Squadron. Fast conversions were a feature of the trials, only 20 minutes being required to change the accommodation from 30 troop seats to heavy-freight hold. Forty minutes sufficed for the change from 40-seater to heavy freight platform dropper. Other arrangements provide for 20 tons of equipment, 92 combat-equipped troops or 70 stretcher patients.

During one six-day period a single C-130 made 25 supply-dropping sorties. On one occasion a freight platform was dropped from the ramp and closely followed by five parachutists. On another occasion a 22,235 lb Marine Corps weapons carrier was dropped; this, also, was followed by paratroopers. Some snags were revealed, but general results were satisfactory. One undercarriage unit refused to extend, necessitating a wheels-up landing, but the only damage was to the under-skin of the fuselage; formers and frames remained undamaged and the aircraft was declared fit to fly. The undercarriage was later worked down and locked and the Hercules flown back to Marietta for inspection.

A troop-carrier wing of Tactical Air Command, which will receive C-130s in December, was represented at the trials and assessments were made of spares, maintenance and crew-training requirements. Paratroopers were supplied by the 82nd Airborne Division and four colonels were among those who made jumps.

N. Z. AGRICULTURAL AVIATION SHOW

WILSON AERODROME, Palmerston North, New Zealand, is the location for the international agricultural aviation show —believed to be the world's first—which is taking place today and tomorrow, November 9 and 10. Organized by the Aviation Industry Association of New Zealand in collaboration with commercial organizations and government departments, the show concludes the 7th International Grassland Congress, which is being attended by some 200 overseas scientists and 100 New Zealand grassland experts, at Massey Agricultural College, Palmerston North.

Among the aircraft scheduled to participate are production models of the Auster Agricola and the Edgar Percival E.P.9, in addition to the established types (such as Tiger Moths, Fletcher FU-24s and Cessnas) already used in large numbers on top-dressing and other agricultural work in New Zealand. A special hill-country display of top-dressing is to be staged in the Manawatu Gorge district, and (according to the initial programme) a massed fly-past of over 100 aircraft will also be included.

The gate takings are to go towards a trust fund for the benefit of dependents of pilots killed or injured in agricultural flying.

HUSTLING AT FORT WORTH

IT was officially announced on October 29 that on that date the first Convair B-58 Hustler began its taxying trials; the first flight was expected within ten days.

The B-58 is America's first supersonic bomber; a photograph appeared in our issue of September 14 and an illustrated analysis of the design in our issue of September 21. Of delta layout, the wing carries elevons at its trailing edge and from it are slung the four General Electric J79-GE-1 afterburning turbojets, each of 15,000 lb thrust.

Dimensions are, approximately: span, 55ft; length, 95ft; and height on ground, 30ft. The crew number three, comprising: pilot; navigator/bombardier; and defensive systems operator. Sixteen complex major sub-systems are fitted, and all—including the defensive system—are described as "virtually automatic and capable of accomplishing their work with a minimum of supervision from the crew." The U.S.A.F. assigned Convair full responsibility for designing and building the airframe and for choosing and installing all other equipment apart from the engines. The total list of B-58 sub-contractors includes some 3,000 names.

HERE AND THERE

SLEEK CAT: This new—F11F-1F—version of the U.S. Navy's Grumman Tiger is fitted with a General Electric J79 turbojet in place of the former Wright J65 (Armstrong Siddeley Sapphire licence). Its area-ruled configuration is admirably displayed.

Gnats for Finland

IT was announced last Tuesday that the Government of Finland have signed a contract "for a number" of Folland Gnat light fighters for their air force. Deliveries will begin towards the end of next year. The Gnat order, the first to be placed by a European country, follows India's recent £3m contract. Finland, whose air strength is limited by the 1947 Paris treaty, has a mixed force of largely obsolescent equipment.

Dutch Commemoration

ON June 10 next year a new international aviation show is to be held at Ypenburg airfield. It will form part of the 50th anniversary commemorative celebrations—culminating on October 17, 1957 (not 1956, as previously reported)—of the Royal Dutch Aero Club.

S.B.A.C. and Free Trade Area

ONE of the 128 trade associations which have indicated their support for the proposed European free trade area is the Society of British Aircraft Constructors. A letter summarizing replies on the subject from 128 out of 287 trade associations and 525 of the 7,400 individual member companies of the Federation of British Industries was handed to the President of the Board of Trade on November 1.

Aviation Medicine Discussed

THE first European Congress of Aviation Medicine, held last week (October 30 to November 1) at The Hague, was attended by 167 participants. This total included 55 from Holland, 33 from the U.S.A. (mainly members of the U.S.A.F. in Europe), 19 from Sweden, 11 from Canada, 6 from Germany, 9 from Great Britain and 5 from Switzerland. Under the presidency of Dr. J. Jongbloed the delegates discussed a number of topical subjects, among them pilot-fatigue, the effect of extreme accelerations, and the formation of a European body on the lines of America's Aero Medical Association.

Gliding Angles

A DISCUSSION on gliding between Ann Welch, Cdr. Nicholas Goodhart, R.N., and Philip Wills is to be broadcast on the B.B.C. Home Service at 7.45 p.m. on Friday next, November 16. The chairman will be Peter Scott, the well-known ornithologist and artist, who is a member of the Bristol Gliding Club.

Dial WR4 5555

THE telephone number of Vickers-Armstrongs (Aircraft), Ltd., at Weybridge—Byfleet 240—which they were given on August 17, 1917, when they were starting design work on the Vimy, has been changed. It is now Weybridge 5555 (the dialling code is given above).

No Badger by Beech

THE name of the Beechcraft Badger twin-engined executive aircraft has been changed to Beechcraft Travel Air. Says the company: ". . . the Air Force authorities feared that in the event of an attack on the United States there might be some confusion between identification reports of the Russian Badgers (bombers) and the Beechcraft Badgers by some spotters on the defense network. This could involve an additional hazard to our national security and possibly some hazard to the occupants of a Beechcraft Badger, which might be the unintentional target of missiles or other projectiles. . . ." The first aircraft to carry the name Travel Air were designed by the late Walter H. Beech in the mid-twenties.

New Guinea Helicopters

FOUR of the new Netherlands-built Kolibrie helicopters are to be taken on the big Dutch expedition to the New Guinea interior in early 1958. Other aircraft will include D.H.C. Beavers and, possibly, the Twin Pioneers of de Kroonduif, the K.L.M. New Guinea company.

Aircraft Golf

IN their final meeting of the season, a team from the Aircraft Golfing Society defeated the Foreign Airlines G.S. by 3½ matches to 2½. In the top match, S. M. McCready and B. D. Songhurst, round in 67, were beaten one up by E. May of Trans-Canada Air Lines and Byron Rogers of American Airlines.

S.L.A.E. Special Meeting

A SPECIAL meeting of the Society of Licensed Aircraft Engineers, on the subject of "Non-destructive Testing and Inspection" is to be held at Southampton University tomorrow, November 10. Details from the secretary (Maidenhead 3621).

Single-Channel

LATEST design of the Custer Channel Wing Corporation, of Hagerstown, Maryland, the CCW-2 single-engined two-seater is to be manufactured under licence by the newly formed Custer Channel Wing Mfg. Corp., of McAllen, Texas. The company claim that the new machine, developed from the twin-engined Custer, will be capable of taking off and landing at 5 m.p.h. in less than its own length (18ft), will fly at about 200 m.p.h., and will be ready for test by mid-1957. It will have a 240 h.p. engine.

R.Ae.S. Branch Appointment

AT a meeting of the newly formed London Airport branch of the Royal Aeronautical Society on October 30 it was announced that Mr. G. W. Hall, A.F.R.Ae.S., assistant managing director of the Fairey Aviation Co., Ltd., had been elected first president. A lecture on *Design Problems of a Large Helicoper*, by Dr. G. S. Hislop (Fairey Aviation), was received with obvious interest by the 90 members present. The next meeting (November 27) will include a lecture by Dr. K. C. Bergin of B.O.A.C. on *Aviation Medicine*.

RECIPIENT of the first award under the Helicopter Association's Alan Marsh Memorial Trust is Mr. M. A. P. Willmer (right), seen here with his flying instructor, Mr. R. Hazlehurst, and an Air Service Training Hiller 12C. The award—a full basic course of technical instruction—was made to Mr. Willmer "for his exceptional ability in the technical study of rotary-wing flight whilst a student at the College of Aeronautics." He also won the 1955 Cierva Memorial Essay competition.

Two of many outstanding contributions to Britain's Air Power

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by
Gloster Aircraft Co., Ltd

Armstrong Siddeley Sapphire Jet engine
by
Brockworth Engineering Co., Ltd.

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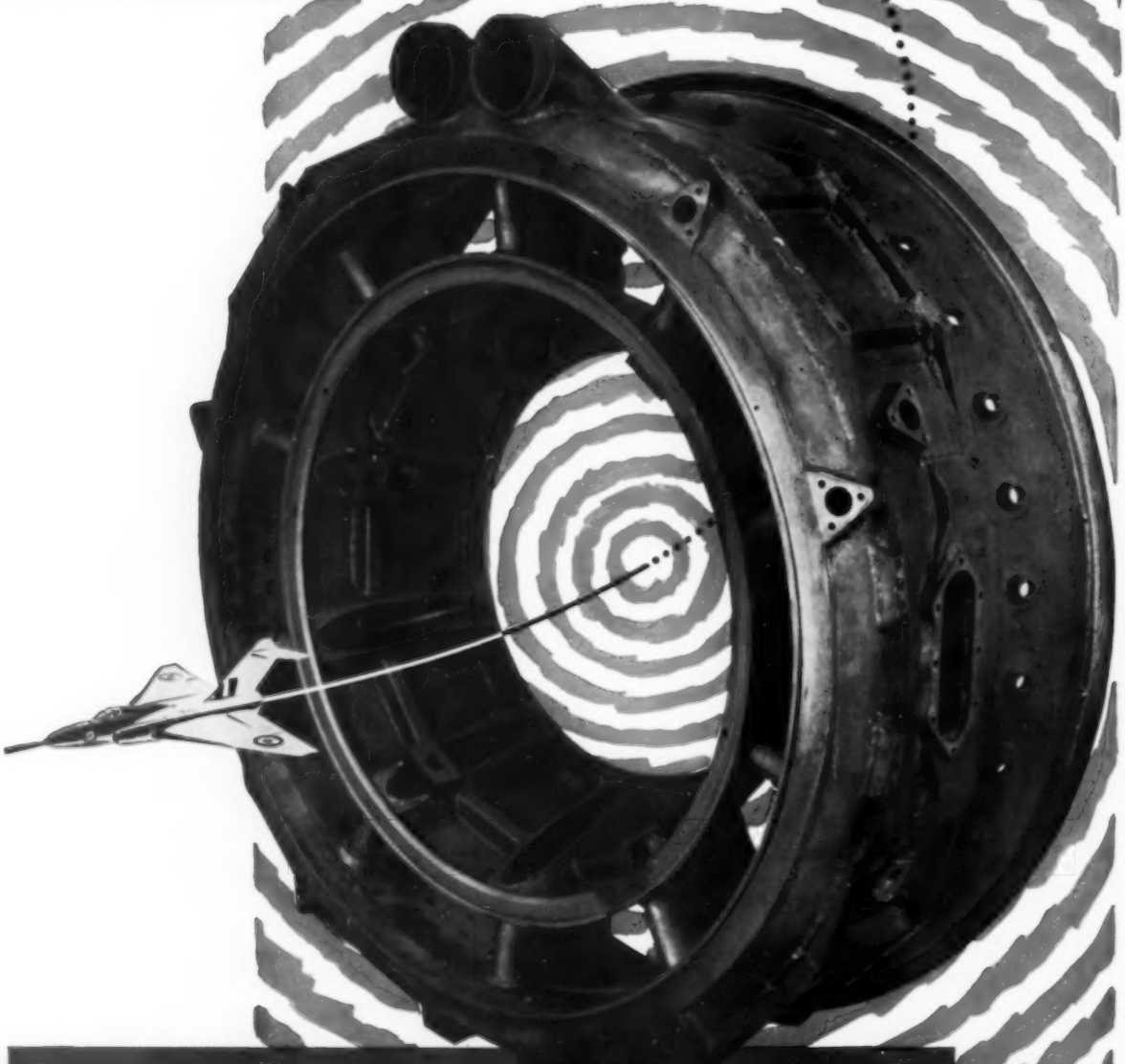


BY SANKEY BILSTON

The illustration shows the Centre Section for the Sapphire V1 Jet Engine. Fabricated in S5 sheet steel, this intricate unit is stress relieved and pressure tested, internal mountings being first X-rayed. Similar Centre Sections for the Sapphire V16 are being manufactured in S5 and also in stainless steel. Sankey's assist in all-engineer in this field of activity.

JOSEPH SANKEY & SONS, LTD., ALBERT STREET BILSTON, STAFFS.

One of Fison-Airwork's hard-working pair of Westland S-55s. The company, Britain's foremost aerial spraying organization, also operates eight Hiller 360s and associates own many fixed-wing machines.

A FIELD FOR THE HELICOPTER

Fison-Airwork's Aerial Spraying Service

ALTHOUGH the farmer is by popular tradition a grumbler, he appears at least to have the aviation business on his side. In his remorseless battle with nature and the elements to prise his livelihood out of the soil, he has enlisted the aeroplane as one of his most effective implements. Even though the home market is small in comparison with the vast agricultural industries of other countries, two British aircraft constructors have seized the opportunity of supplying the farmer with the sort of aeroplane he needs. The Edgar Percival P.9 and the Auster Agricola, subjects of "In the Air" articles in two recent issues, are in our view certain of big business in the years to come. But what of the helicopter?

Its protagonists claim that on every count but one—cost of operation—the rotary wing scores over the fixed wing for aerial spraying. Indeed, they say, despite the fact that the farmer may have to pay twice or thrice as much per hour for a helicopter as for a fixed wing aircraft (a typical cost is £40 per hour), he will still need it for many jobs.

Is there an opening for a really cheap-to-operate specialized helicopter for agricultural work? Obviously, however carefully designed, a machine of this kind could never approach the economy of such specialist fixed-wing competitors as the P.9 or the Agricola—but it could sufficiently reduce the disparity in cost to open up a big market. Furthermore, it could widen further the field in which the helicopter excels—that multitude of industrial tasks which only a vehicle infinitely controllable in all three dimensions can attempt.

It was with such matters in mind that we recently visited Fison-Airwork at their U.K. headquarters near Cambridge. They operate a mixed fleet of two S-55s, eight Hiller 360s, and other aircraft, and are thus well qualified to judge the relative merits of fixed- and rotary-wing in agriculture. This firm is, in fact, the biggest and one of the most experienced industrial helicopter operators outside America and Australia, and is undoubtedly second to none in its experience of aerial spraying. The firm has its roots in Fisons Pest Control, Ltd., whose aviation division was merged intact in May 1955 with the British independent operators, Airwork, Ltd. They are a good example—if politics may be allowed to intrude—of what a private civil operator can achieve unfettered by Government control. Fison-Airwork's operations are mainly overseas (with associated companies in East Africa and South Africa), and are truly fascinating in their variety.

Our questions centred mainly around helicopter operations. First, why did such jobs pay if they were so much more expensive than those done by competitive fixed-wing aircraft? The answer was that there are countless jobs which (if it is accepted that aerial spraying is essential) the fixed-wing aeroplane cannot perform. There may be no landing site, the area may be too small for manœuvring, there may be hazardous obstructions. Furthermore, it is claimed, the application—whether of fertilizer or a pest-killer—may be so critical as to its distribution that the necessary degree of control can only accurately be achieved by the helicopter. An example in mind is the spraying of banana plantations in Jamaica against leaf-spot. This job was only recently undertaken by the company, and from early results it seems to have supplied the answer to one of the banana grower's biggest problems.

Second, what sort of helicopter did Fison-Airwork consider should be developed for aerial spraying? The suggestions came in detail. They were: (1) A sturdy, simple and straightforward machine, costing about £5,000, with quick-change components. It should be possible to remove the engine, transmission, rotor head and other items with ease. (2) All unnecessary items should be eliminated, at the expense of good looks. (3) The fuselage structure should be open, and preferably of tubular construction. The undercarriage should be interchangeable between four wheels and skids. (4) The rotor blades should be metal. The clearance of the fuselage from the ground should be sufficient to allow installation of the insecticide tank. Attachment points should be provided on each side as an alternative. (5) Seating for the pilot should be in the centre; if this cannot be achieved, he should sit on the left. (6) Trimming should be electrical and the controls should be light. It is unimportant whether the cyclic-pitch lever is of the overhanging type or comes from the floor. The lever-type throttle (as on the Hiller 360) would be preferred to the twist-grip type. (7) Cockpit canopies should be easily detachable, and convertible to completely closed or completely open, with doors separately removable. (8) The machine should be kept as small as possible. (9) An engine of 250 to 300 h.p. would be preferred. (10) The payload of a machine should be a minimum of 900 lb, hovering ceiling at full load 5,000ft, cruising speed 100 m.p.h., and endurance 2½ hours. A simple enough category of requirements—with the exception perhaps of the £5,000 first cost.

In conclusion, we quote Mr. J. E. Harper, co-director of Fison-Airwork and a helicopter pilot of long experience. He was speaking of agricultural flying in general, rather than of helicopter operations in particular, but his words lend colour to one of aviation's most difficult but fascinating activities:—

"There is no doubt in my mind that few operations are as arduous on the flying side or in the maintenance field as those met in aerial spraying—no better medium to train safe captains for helicopter airlines of the future! I claim this because flying conditions are tiring due to concentration during prolonged periods of low flying; in fact, over 85 per cent is done a few feet above the ground. Continuous manœuvring and turning, avoiding obstacles, combined with frequent take-offs and landings necessitate flying the machine all the time with no margin for error resulting in physical fatigue. An average of four hours flying per day is sufficient on this type of work. Some of our pilots have exceeded eight hours on some days, but it would not be possible to keep up to this figure for more than the odd occasion . . ."

We left Cambridge thinking it might be rewarding for the helicopter manufacturing industry to look into aerial spraying a little more closely. As with jet and turboprop in transport, there would seem to be room in agriculture for both fixed-wing and rotary-wing—if the latter were designed with the same imaginative approach as were the P.9 and the Agricola.

COSSOR COMMUNICATIONS

AS a subsidiary of A. C. Cossor, Ltd., the Cossor Communications Co., Ltd., has been formed to extend the telecommunications interests of the Cossor group, and a development team is engaged on an ambitious programme in which, it is stated, the fullest advantage will be taken of new techniques, particularly the use of transistors, printed circuits and mechanized production methods.

The new company will take over the handling of sales of existing Cossor communications sets, such as the WS.53 and T.1509 transmitters used by the Army and the R.A.F. and exported. Main emphasis, however, will be on a new range of designs, varying from light portable sets to heavy equipment. The company's activities will extend not only to radio but to line communications, in co-operation with the Sterling Cable Co., Ltd., the cable-making subsidiary of the Cossor group.

Mr. Henry Chisholm, joint managing director of A. C. Cossor, Ltd., is chairman of the new company, with Mr. T. S. Heftman as general manager and technical director. The sales division (Mr. I. Campbell-Bruce is sales director) is at Cossor House, Highbury Grove, London, N.5 (Canonbury 1234).

FUNCTIONAL EFFICIENCY

—of Service and Civil Aircraft: A Royal Aeronautical Society Discussion

BOTH civil and Service aspects of the problem of the operating reliability of aircraft were put forward during a discussion meeting at the Royal Aeronautical Society in London on October 23. The two main contributions were by A.V-M. A. F. Hutton, C.B., C.B.E., D.F.C., Director-General of Engineering, Air Ministry, and Mr. Charles Abell, O.B.E., chief engineer of B.O.A.C.; the chairman of the meeting was Mr. R. E. Hardingham, C.M.G., O.B.E., secretary and chief executive of the Air Registration Board.

A.V-M. Hutton's definition of an aircraft's functional efficiency was "a measure of its technical ability to perform satisfactorily the task for which it was designed." The *Operational Requirement* of an aircraft, he said, included the required technical reliability; this was that an aircraft should be capable of completing 100 hours' flying with freedom from technical failure and the minimum of servicing. "This represents an ideal which so far we have never attained and, in my opinion, it is doubtful if we ever shall."

The minimum requirement for functional efficiency which must be met if the Service was fully to discharge its responsibility, A.V-M. Hutton submitted, was that the aircraft and its equipment be capable of undertaking a single operational sortie without incurring a technical defect. This minimum requirement was not met at present. For example, during last year's Fighter Command exercise 283 sorties were abortive because of technical defects. This, on the basis of 12 aircraft per squadron and three sorties per aircraft per day, was equivalent to an operational loss of nearly eight squadrons for one day.

Another method of expressing the problem was to compare the number of defects with the hours flown. The overall picture for four types of operational aircraft showed a random defect rate of 0.9 defects per flying hour, and a total defect rate of 1.2 defects per flying hour (the difference being caused by defects found during scheduled servicing).

The reasons for this state of affairs, the speaker suggested, fell into five main groups. These were: (a) Failure inherent in swift technical advances; (b) failure of design to meet the specification; (c) failure of the specification to state the requirement; (d) fortuitous external factors; (e) bad servicing.

Of these, the first two were the most important. Service aircraft needed the application of the latest advances in technical research —even before all associated problems had been investigated—in order to achieve operational superiority, but it seemed that the incidence of failure arising from this source could be reduced. The second reason listed included faulty design practice and unsatisfactory manufacturing processes; while an adequate fund of experience did exist, it appeared that this experience was not always available to those concerned with design.

The incidence of failure in Service aircraft and the cost to Service efficiency, the speaker summed up, was far higher than should be considered either reasonable or acceptable; the majority of failures occurred at random during periods of accepted reliability; they occurred in lesser details but were no less costly for that reason; and they were a problem common to all types of aircraft.

Problems of Development

The two main causes referred to were both basically development problems. In new designs much greater efforts should be made to obtain the maximum of experience in the shortest possible time, and development should not be considered to have ceased when the aircraft C. of A. was granted. Only when new types reached the Service "in some numbers" could development be said really to begin.

A.V-M. Hutton continued; "We in the Service have not been entirely free from blame, for we tend to insist that we should only receive fully proven aircraft, not always realizing we have our part to play in development. I think we did realize some of our responsibilities in this matter about six years ago when we introduced a defect-recording system which is now in use throughout the Royal Air Force. A little while later we introduced intensive flying trials of new aircraft, our object in both cases being to obtain accurate and statistical evidence of our experience. Unfortunately industry on the whole has been slow to take advantage of this information, though very recently copies of our reports on intensive flight trials have been sent to the firms concerned."

The most profitable field for saving time, the speaker concluded, was in the development period. The principal reason for slow development was the gap between the designer and the user of the aircraft. "If we are to improve, this gap must be considerably narrowed and, better still, closed."

The second main paper was by Mr. Charles Abell, who discussed functional efficiency from the airline point of view. The fundamental criterion, he said, was the aircraft's revenue-earning potential, and so the flying rate must be as high as possible.

The time spent by aircraft on the ground could be classified under five headings; scheduled transit time, scheduled terminal ground time, unscheduled ground time, maintenance, and serviceable at base.

Scheduled transit time at present normally amounted to 45 min. Manufacturers and refuelling companies had kept pace with the demand for higher fuelling rates, and aircraft were functionally efficient in this context. Scheduled terminal ground time represented servicing time at the overseas base and pre-flight and post-flight work at the home base. In the overseas element, which was by far the larger, there were two factors; the time found necessary by experience to ensure that the return flight started punctually, and the fixing of the departure time at a convenient hour for the travelling public. The first of these factors reflected functional efficiency, for this time allowance could be reduced if outward delays could be eliminated.

Unscheduled ground time, Mr. Abell continued, was the measure of unpunctuality. Not only did it affect the overseas turn-round time, but it was also one of the criteria by which passengers judged an airline's efficiency. Punctuality standards achieved by B.O.A.C. Constellations on the Kangaroo route to Australia showed that, over a six-month period, 95 per cent of all flights left London within one hour of schedule and 81 per cent arrived at Sydney within the same tolerance. Homebound, some 87 per cent left Sydney within one hour, but only 55 per cent arrived at London within this margin. Most delays arose either from weather or from technical troubles; in the case of B.O.A.C. Constellation aircraft, the latter was the prime cause. The powerplant created by far the greatest amount of trouble, accounting for approximately 60 per cent of all the time lost due to technical causes. The same ratio applied to B.O.A.C. Stratocruisers, but the figure for Argonauts rose to 80 per cent.

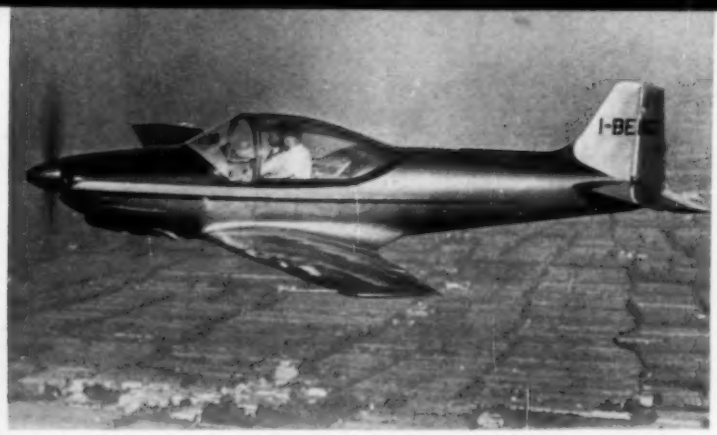
Efficiency of Maintenance

The amount of time required for maintenance was obviously closely allied to functional efficiency, although the manner in which an airline went about the job also affected the situation markedly. Assuming that the maintenance activity were efficiently organized and performed, functional efficiency here was related to (1) the reliability or longevity of components and structural parts, (2) the ease with which these could be removed for rectification or overhaul, and (3) the ease with which these could be overhauled. These were the "three Rs" of reliability, removability and renewability.

The fundamental responsibility for "design for maintenance" lay with the manufacturer and not the operator. An airline was only too keen to operate its aircraft to the best advantage, and undue distraction from this activity into the fields of engineering development could only be to the detriment of this primary interest. The need for close liaison between the manufacturer and the airline could not be stressed too strongly; "It has been my experience that manufacturers differ widely in the interest they take in their products once they have sold them. I recall one large firm which has only recently seen to it that the reports of their by no means inconsiderable service department are channelled back to the design teams! Undoubtedly, the accessory manufacturers are much more guilty in their failure to find out how their products function in the hands of airlines, and I could mention several who apparently have no established channels of communication, either with the airline or the aircraft manufacturer to whom they are effectively subcontractors. . . . Obviously, a close link between manufacturer and operator helps *both* sides to do better business."

The time allowance in the "serviceable at base" category was partly conditioned by the route-operating pattern of the aircraft, partly by the fixing of departure times convenient for the public, and partly by the need for a high standard of departure punctuality.

The continual battle towards functional efficiency, Mr. Abell concluded, was the spearhead of good operations. This battle, if well-directed, kept an airline ahead of its competitors. Overall efficiency needed sound design and workshop practices, and punctual delivery. If thought had been given to reliability, removability and renewability, the aircraft would be popular with the airline engineers. Finally, if in addition it had passenger appeal and thus produced high load factors, then the machine could be said to be truly efficient.



FALCO F.8L

A very fast and fully aerobatic two-seater, the little Falco F.8L is in production near Milan. The cockpit view, left, shows instruments and radio, with electrical control panel at left. Engine, fuel and trim controls are on the central pedestal and shelf.

THE Italian Aviamilano Falco F.8L, with the 140 h.p. engine, is derived directly from the prototype F.8 with the 90 h.p. engine. It differs from it not only in having greater power, but also in increased size and comfort, in greater stability, and in other ways. The engine is a Lycoming 0-290-D2B, giving 140 h.p. at 2,800 r.p.m. and a maximum continuous power of 135 h.p. at 2,600 r.p.m. Seating is for two, side-by-side, under an entirely transparent plastic sliding canopy. The nosewheel undercarriage is electrically retractable, with a mechanical stand-by; later aircraft have complete fairing doors, resul ing in increased cruising speed. Full blind-flying instrumentation, V.H.F. radio and A.D.F. can be fitted. There is ample luggage space.

From the cockpit the pilot's visibility is complete throughout the 360 deg circle, and a darkened central portion of the canopy gives good sun-shielding for both occupants. Seat harness is fitted (the F.8L is fully aerobatic) and the canopy structure offers adequate overturning protection. Levers and switches are all well placed and clearly marked and come easily to the hand of a s.rapped-in pilot.

The nosewheel is steered from the rudder pedals and both mainwheel hydraulic disc brakes are applied together by a heel pedal between the rudder pedals. A catch locks the brakes for parking. Taxying with precise directional control is very easy. The electrically actuated flaps can be set at any angle down to 50 deg, the 20 deg setting being recommended for take-off; trim is set neutral. At 31 m.p.h. the nosewheel is raised and the machine unsticks cleanly at 56 m.p.h. At full load the rate of climb settles down to between 1,180 and 1,380 ft/min. During the climb and in all other conditions static and dynamic stability, with stick both held and free, is excellent. The best full-power climbing speed is about 84 m.p.h.; at lower speeds engine cooling does not deteriorate.

Stalls, both in level flight and at accelerations as high as 4g, are straightforward, clearly defined and are not accompanied by dropping of a wing. In all configurations distinct and increasing vibration denotes the approach of the stall. In the landing configuration the stalling speed is about 49 m.p.h. During testing, some 5g were registered on touch-down. No damage at all was caused. Control and stability remain excellent at speeds just above the stall. The Falco will spin only if made to do so; and after five turns to right or left it will recover immediately if the controls are simply centralized. Elevator trim, controlled by a knurled wheel on the floor between the pilots, is effective; and trimmed speeds correspond to the requirements of the international C.A.R.3 specifications.

At the Falco's ceiling, above 16,400ft, dynamic and static stability in all three axes remains good, even at accelerations of 3g to 4g and at different trimmed speeds. Decreased temperatures at altitude have no adverse effects on the controls in terms of increased friction or break-out forces. Trials of rate of roll, induced roll, crossed controls and other qualities have given entirely satisfactory results.

In straight and level flight the true production aircraft, with undercarriage fairing doors, flattened (instead of bulged) canopy-ridge contour and other refinements, has exceeded 200 m.p.h. In a dive it has exceeded 250 m.p.h. without trouble. During the Grand Prix de France I covered the 145 miles between Biarritz and Toulouse in 46 min 43 sec, an average speed of 190 m.p.h. timed from unsticking to overflying the finishing line. This was with a Falco without fairing doors and with the bulged canopy which has since been abandoned because it caused some turbulence. This performance was officially measured by the Aero Club of France officials and was achieved without a tail wind. Corrected to allow for take-off and climb our level speed was in fact 196 m.p.h.; and the airframe refinements mentioned above would easily give a further increase of 6 to 9 m.p.h.

Aerobatics in the Falco are pleasant and present no difficulties. Inverted, it remains controllable and glides easily. Particularly fine proof of the Falco is the demonstration given by Ettore Wengi, a well-known Falco owner. He concludes with a dive to ground level at about 235 m.p.h., followed by a 4g pull-up and a long series of upward rolls. After five or six of these the aircraft is well over 3,000ft up.

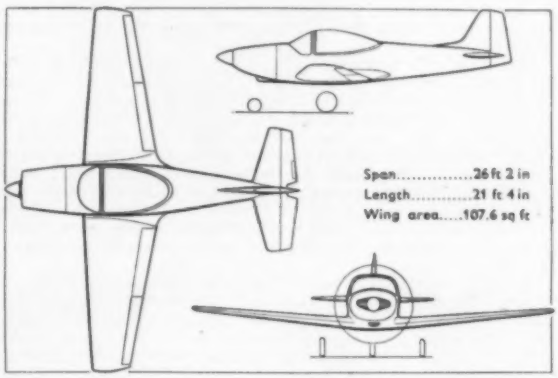
On the landing approach, the nose-down trim changes caused by lowering undercarriage and flap and reducing power can easily be held on the stick or trimmed out. All-round visibility is excellent and response to small alterations of power is immediate. The best approach speed is between 71 and 78 m.p.h. and the elevator remains very effective up to the last moment.

Changes of configuration are never difficult and the transition from the landing to the climbing condition is simple by virtue of the aircraft's power and stability. Horizontal and vertical acceleration are considerable and more than sufficient even when opening up from speeds as low as 6 m.p.h. above the stall.

As a measure of landing performance the figures established during the Grand Prix de France are worth quoting. At Biarritz, with the early machine described above, I stopped 752ft after crossing the 9ft 10in obstacle, with a g-meter reading of 1.4g on touch-down. This indicates a normal gentle landing; and I was carrying a 68 lb extra load.

Altogether I feel that the Falco can be considered as perfect in its category. It is easy to fly, safe, strong and fast, and is stressed for full aerobatics with two people and 176 lb of fuel—almost up to the gross weight of 1,540 lb. With two people and 88 lb of baggage it has a useful range of 750 miles. This aircraft has really captivated all the pilots who have so far flown it, and I believe it has a great future before it.

VICO ROSASPINA



THE IMPORTANCE OF TIME

—in Aircraft Manufacture: A. Cdre. Banks' R.Ae.S. Lecture—Part II

IN our issue of October 26 we published the first half of the much-discussed paper recently given before the Royal Aeronautical Society by A. Cdre. F. R. Banks, C.B.E., O.B.E., a director of the Bristol Aeroplane Co., Ltd., and well known authority on engines. In the second part—like the first, reprinted here in full by permission of the R.Ae.S., the lecturer went on to discuss the production of civil aircraft, engine development, and concluded by touching on more general problems.

In this country [he said], with little internal air traffic but with lengthy communications and sea and air routes to all parts of the Commonwealth and the Empire, and to the rest of the world, we would appear to have all the encouragement needed for our future in the air. But we do not have the domestic (military and civil) market of the United States, which in itself demands and absorbs a very large aircraft production (representing over 60 per cent of the world's civil aircraft requirements) and gives them an almost overwhelming advantage in acquiring elaborate production equipment and stabilizing the industry at a good working (capacity) level.

In having two nationally owned airlines, who will at least give British aircraft first consideration, we are indeed lucky, since it is the only effective way of giving our aircraft manufacturers a start in civil aviation. But these two airlines do not represent, in size, a break-even market, unlike American operators who offer an enormous outlet for the U.S. aircraft industry.

In fact, were it not for the support of the Government in the past, in ordering prototypes and bearing largely the costs of their development, and also the encouragement of the two national airline companies, it would have been practically impossible for us to have attempted to compete in the civil aviation market. The cost of developing an engine alone would have prohibited this. The American operators are well placed in the latter respect, since their large and comprehensive military programme eventually makes available well-developed engines mostly adaptable to civil use.

There is a minimum size or capacity for a firm producing civil aircraft if it is to meet the rate needed to execute orders in reasonable time, and also to cater for the individual customer's needs; and profitable manufacture will be very difficult to achieve if production (with about 50 per cent sub-contracting) is less than about ten large (150,000-300,000 lb) machines per month. This, in my opinion, is a realistic figure if we are to think of competing with the U.S.A., and calls for much larger production units if it is to be considered at all.

Also in the case of the smaller (100,000-150,000 lb) jet aircraft at present in the project and design stages in America, one firm is planning to produce, at peak, ten per month; and there are three other firms all equally large and capable.

These production rates cannot be achieved without the commensurate capital expenditure on the very expensive and elaborate tools and tooling of the type now in general use in the United States. In fact, it is hardly possible to attain the low structure-weights and, equally important, the high degree of quality in the modern airframe without the large presses, the "sculpturing" machines or skin millers, the stretch-forming equipment and, even, the automatic riveting machines which the American industry is employing today.

The basis for the outputs given above stems from the fact that customers cannot, in the tough competition of airline operation, wait unduly long for their aircraft; and delivery must also be gauged to produce a yearly total which will ensure reasonably rapid recovery of the development and tooling charges in a competitive sales price.

Before all this happens, there is much preparatory work to be done. First, there is the market research—to judge whether or not the proposed aircraft is of the right type and size. Then must come the decision to build a prototype, to prove the designed performance and constructional features. All this "costs the earth," but it is very difficult to sell anything off the drawing board in the open market unless the manufacturer either has a large background of experience, and success, in building civil aircraft or the machine is, more or less, a direct development of an already well-tried model. The trend is now to avoid prototypes, as such, and to regard the first machine built as the production model or pattern.

Accurate estimates of the design and engineering effort are needed, together with the time and cost of manufacturing the prototype and getting the production version through its C. of A. tests; and jigging and tooling must be put in hand early in the prototype stage in anticipation of sales and to ensure delivery dates being kept. The scheduling of delivery dates and giving the actual days of delivery, is a sign of efficiency.

The above procedure must be followed so as to determine the sales price and the number of machines to be sold to reach the break-even point. Then the airline operators can again be approached and signed up, after the necessary guarantees and warranties have been agreed.

Later, if a second wave of orders results from satisfactory operation, the "learning curve" factor and inflation will both operate to show whether or not the sales price can be lowered or must be raised.

The financial risk is too great in these days to embark upon the design, manufacture and development of a new (prototype) aircraft, even with Government help for these phases, if a "by guess and by God" attitude is taken; and unless the procedure outlined above is followed, the results will be chaotic and costly in the extreme.

What I am really saying is this: if we are to sell against America, and probably Russia, we have to get organized into larger technical and production units or give up the idea of meeting this heavy competition. But the market for large, high-performance aircraft appears to have been filled for the next fifteen or twenty years.

This may seem at variance with what I have already said regarding the procurement of military aircraft (that if a firm produces a good prototype but has poor production facilities, the production rate may be supplemented by placing orders for complete aircraft with a less technically successful firm), but the case of the civil aircraft is rather different.

Since military aircraft have all their development costs defrayed by the Government and only partial support has so far been given to civil machines, sufficient profit must be made by the parent firm to cover some of the latter's development charges and leave a reasonably high proportion available to plough back, so as to proceed with the next step. Therefore, if other firms are brought in to supplement the parent firm's production (of complete aircraft) the profits will obviously be severely reduced, thus restricting the scope of the parent firm's future developments.

It may, however, be nationally necessary to adopt for civil aircraft the procedure I have already outlined for the procurement and manufacture of military machines, since the shift of emphasis from military to civil aviation makes more urgent the need for maintaining the stability of the aircraft industry, as a whole; and it should in the long run prove more advantageous to meet our own civil needs than to pay out further dollars, even if the total number of aircraft built does not reach a normally economic figure. But with full Government support in meeting the design, development and tooling charges, it is a practical way of keeping an important industry alive and active—and ensuring a limited profit.

To the great credit of one British firm, it has sold a fairly large number of medium size propeller-turbine aircraft to some North American airline operators. This has created a precedent and greatly increased the prestige of our industry as a whole. But we should not deceive ourselves that the American airline operators, in particular, will buy British in future unless we can continue to compete qualitatively and quantitively with U.S. constructors and offer something very attractive in performance and delivery —since the latter are already in the process of filling their gaps with a variety of large and small jet aircraft and a propeller-turbine machine.

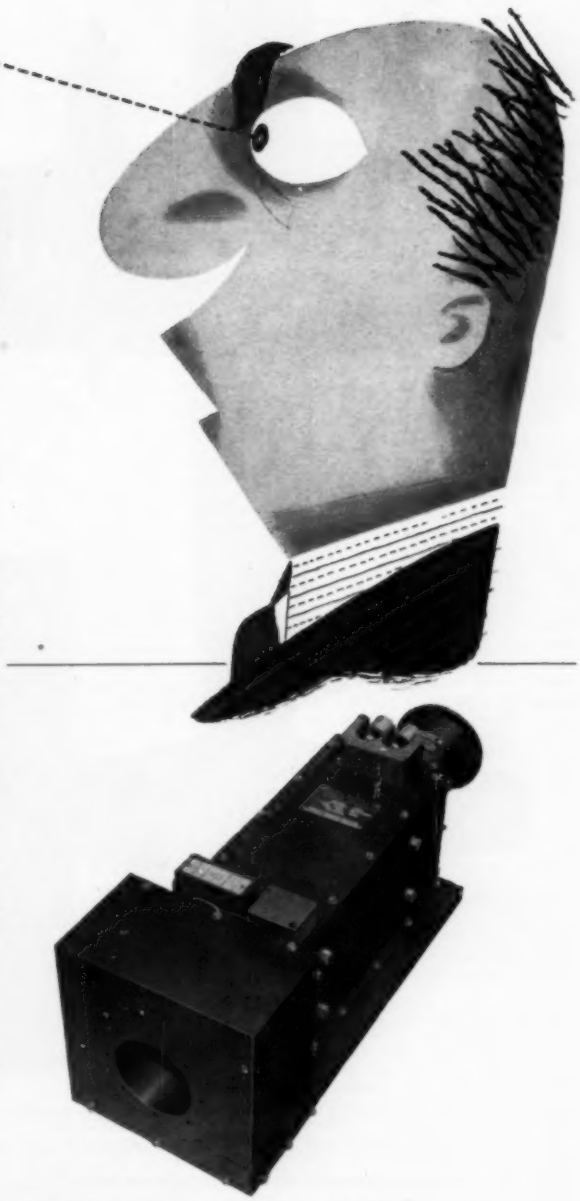
All this is not despondency but realism, and a challenge to the industry to put on a completely new look in preparation for the events of the next decade or two. And can anyone deny that we need an entirely new approach to the business of meeting the increasingly rigorous demands of aviation?

To my mind, our "new approach" should start with a good look at the methods of the American aircraft industry and we should then adapt and modify their techniques and procedures for our own needs.

We have not yet grown out of the stage of throwing a cocktail party, at the drop of a hat, for an "achievement" which should now be regarded as an ordinary job of work. In fact, we too often act like a bunch of enthusiastic amateurs. Paraphrasing the Red Queen in *Through the Looking Glass*: we don't want to be a "slow sort of country" and in aviation we have to run very fast to stay in the same place, but twice as fast to be in the lead.

Engines. In the past—that is, between the two world wars—an engine was created or evolved more or less directly as the result of an Air Ministry requirement, to meet military needs, and civil

AC + TRU = DC ?



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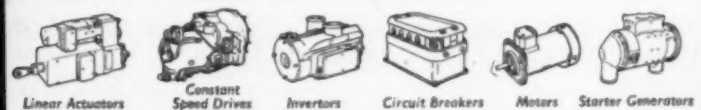

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aviation then took a reasonably well-developed military model and used it in de-rated form. This practice, with four important exceptions, has not substantially changed since the last war, but the cost of engine development is now so great that, without Government support, we could not remain in the strong position we are today—with British engines highly regarded by all and sundry.

It is a platitude to say that a strong and healthy engine industry is needed before the aircraft industry can exist; and while this has long been recognized it has not always been easy, due to the enormous outlay necessary to maintain a comprehensive programme of engine development in anticipation of future needs.

The cost of designing, developing and bringing a large turbojet of, say, 15,000 lb thrust to production is in the order of £8,000,000, over about a five-year period. Between the two wars, it was usual to see an engine well on in its development before the airframe to take it was built. This was because four to five years were needed to get a piston engine to type-test standard and into initial production. The aircraft was then designed around the new engine, or one which already existed. The same general procedure holds good today, but with the difference that the timing and matching for the engine and aircraft combination must be much more accurately assessed and more closely co-ordinated.

While the engine has still to lead the aircraft, in conception and development, this lead-time is not so great as it used to be, for the reason that the modern aircraft now takes about as long as the engine to design, build and test—even longer, in some cases! Due to this, and also because the engine must be more completely integrated with (or within) the airframe design, for the reason of the greatly increased performance offered by the turbojet, the aircraft designer gets off to an early start on his new machine, but always with a known engine concept—if no fully developed engine already exists.

Therefore, while the trend of aircraft design would now appear to exercise much greater influence upon engine shape, size and performance than in the past, I doubt if the original practice will be reversed. There have, indeed, been only one or two cases of an engine designed and built for a particular aircraft, and these have not enjoyed success.

Now a word of warning on a situation which may threaten the future of some engines. Owing to protracted aircraft development and the small amount of flying put in by various aircraft in recent years, the development of the engine is in turn being seriously affected. Long-drawn-out and intermittent flight testing can "snowball" into further delay with the tardy appearance of previously unsuspected engine trouble, which will throw out of gear and further prolong the flight-testing programme. Added to this is the time taken to build some aircraft, where engines wait for installation in an airframe which is still years away; and the weight-growth which often occurs in the design stages of an aircraft, due to poor weight control or altered requirements, may demand more thrust—thus absorbing further time and effort. So it can go on, in an ever-mounting spiral of time.

I mentioned earlier that there were four important exceptions to the rule that civil engines generally stemmed from military types. These are the Dart, Proteus, Eland and Tyne; and although the former was originally ordered for a Royal Air Force trainer (the replacement of the Harvard), it was not used for that purpose but found its valuable niche in civil aviation. This does, however, raise the important point of how to accumulate flight hours on a civil engine without a military application; because there has not been, until recently, a Service requirement for propeller-turbine aircraft. In fact, the Britannia will be in civil operation well ahead of the military transport version for the Royal Air Force.

In this connection, the M.o.S. has been very helpful in loaning flying test-beds for the development of civil engines.

The impracticability, today, of duplicating designs to meet a given aircraft requirement has been mentioned. But this does not necessarily apply to the engine, which still requires a high degree of engineering art and considerable "know-how" to meet the ever-increasing demands for improved performance; and since there are different ways of getting better performance, it is not prudent to depend only upon one.

In the engine industry we have the greatest asset and contribution to our strength and prosperity in aviation; and all this could vanish almost overnight and the industry as a whole be made bankrupt by any false moves, in the name of national economy, to reduce the scale of effort—which is already being jeopardized by a slow-moving aircraft situation.

America is not now behind us and has one or two equally good engines, even if all her engine firms do not measure up so closely, one to the other, as ours. We are also at some disadvantage compared with the American engine industry; with their large military and civil production, and with so many aircraft flying, the U.S. engine builder is presented with a statistical appraisal of the behaviour of his product which is otherwise quite impossible to obtain.

It is therefore extremely important that, because of small production, our engine bench and flight development be sufficiently rigorous and realistic to ensure the maximum possible reliability in service. In other words, the need for maintaining our reputation for high individual quality of product was never more necessary. But all this does tend to keep the cost of the individual engine disproportionately high, because of lack of real production numbers.

The American engine builders have elaborate facilities for testing gas-turbine engines at altitude conditions closely simulating those of flight. Supplementing such plant in the individual firms is similar equipment available through the U.S.A.F., the Navy and N.A.C.A.; and while some here have questioned the need for these facilities, and have said that their use had not resulted in superior compressor or engine performance, the lack of them might have produced much inferior engines. Further, it is practically impossible to know beforehand how an engine is likely to perform in an aircraft flying at, say, 60,000-70,000ft, at a Mach number of 2.5 to 3, without such facilities; and it will be risky and somewhat late to wait until the actual aircraft (which has cost millions of man-hours to engineer and manufacture) is ready to fly.

Analogue and digital computors are considered indispensable by the American aircraft industry, and all the engine builders, without exception, use these electronic mathematical aids extensively. Their use does not reduce the need for technicians—rather the reverse—but the operation of the equipment by skilled and knowledgeable personnel eases the load on the individuals in the design and performance calculating teams and allows an enormously increased volume of work to be done, thus expediting the whole design process and ensuring greater certainty in the rightness of choice of the final engine (compressor) design. In fact, to enable better engines to be evolved.

One engine company told me that the very full use they made of this equipment had cost them $1.5m last year, and I know others paying more than this for the lease of such equipment.

The Future.—What, then, is to be the pattern of British aviation? We should take the *realistic* view that it would be unrealistic to attempt to compete with America in the scope, variety and size of their various projects. But, with full Government support, we can meet our own and also some of the world's needs in military and civil aircraft and in engines. Whether we could "leapfrog" the large subsonic civil jets and go for a supersonic machine is a moot point, but it would require an expenditure in money and time of at least £50m (for design, research, two prototypes and production tooling) and ten years to do this; and it could be a disastrous waste of effort if it did not come off or was mistimed.

There is, however, still scope left for our engineering ingenuity in the field of small and moderate size (up to 150,000 lb) machines; and, following the Duke of Edinburgh's suggestions in the Tenth British Commonwealth and Empire Lecture, we should go wholeheartedly into the business of assessing, and then meeting, the needs of the specialist operator.

If the "non-scheduled" or independent operators, as legitimate competitors to the national airlines, were brought into the fold, this would open up a more worth-while market for our constructors.

Militarywise, we should have the supersonic bomber and I.C.B.M. (intercontinental ballistic missile), even if we can only afford to develop one design off each. There is also the air-defence fighter and the military transport.

In the case of engines, we must go all out to compete with America and Russia in quality and performance; and, having gone so far as a leader in aircraft propulsion, we cannot now afford to stand still or "die on our feet." But if our military and civil aircraft effort is allowed to go downhill, the effect on the engine industry will be serious.

A Recommendation.—Before closing, I wish to amplify some of my earlier remarks regarding the need for more efficient and expeditious handling of a requirement by the Air Ministry. One of the difficulties in this connection is that the average General Duties officer who is appointed to these important operational requirements positions necessarily does not have a high degree of technical knowledge—excellent operational officers as all Royal Air Force personnel are. And there is lack of continuity, since they are never kept in these positions for a sufficient length of time to see their work progressed through to any real degree of finality.

There should be a corps of engineering officers of the highest technical qualifications (Shrivenham standards) who would be the "continuity sisters" to the G.D. officers in control; and with engineering officer personnel there could, perhaps, be formed an Air Materiel Command, on the lines of that in the U.S.A.F.

Conclusion.—I am convinced of my thesis, of the need for cutting the gestation period of an aircraft by 50 per cent; and, indeed, one does not have to be a genius to see that there has been something amiss since the war, with the bright spots as rare exceptions. But it is only possible properly to judge and assess our true position by visiting other countries, which I have been doing for many years. We of the industry should be able to look at ourselves

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critically, and it does no good in the present situation to shy away from the facts.

I did not go on the recent trip to Russia, but it is written plainly that, apart from their extraordinary advances in military aviation since the war (when their aviation effort was not a serious factor), the Russians will eventually be competing in the field of civil aviation with subsidized prices and good deliveries.

Something, therefore, has to be done quickly to get us out of what is really a pre-war state of mind, and one feebly grappling with problems far transcending anything of that time or even of the war period. But the answer is not to be found by making a series of drastic cuts, apparently now being considered and, possibly, already put into effect since writing this lecture. Arbitrary cuts are of little use and, indeed, can be completely destructive to an industry which is always delicately poised between prosperity and the bread-line, and upon whose technical and engineering ability the nation's safety so much depends.

The only way to avoid permanent injury to the industry is by reappraisal of the existing projects, full support of civil aviation for all well-considered projects within the industry's capability, and a stable Government (Treasury) policy which will see an agreed programme through to fruition without frequent financial hindrance.

The drastic reductions which are threatened for the defence budget, and which may result in the literal carving up of our Armed Forces to quite ineffective strengths, savour of the traditional British outlook or frame of mind reasserting itself in high places—that, "war may never happen"; forgetting that the reason for the recent international "get-togethers and back-slapping" is that both sides have the nuclear weapon and the means of delivering it.

We enjoy at least the second highest standard of living in the world, but a Welfare State, like any other State, will cease to exist if it is not prepared to defend itself—as I think history can show. If the emphasis is on good living rather than on defending the way of living, the State is on very shaky foundations.

It must be realized that, while we were as efficient as the U.S.A. in producing airframes and engines (in lesser quantity) in the war period of 1939-45, there has since been a big change in the conception and production of the modern aircraft, which now demands *all* "the (new) tools of the trade"; and the equipment previously mentioned is now really necessary for the production of safe, efficient and low-weight airframes of the size (capacity) now considered reasonable for long-range economic operation—also to conserve manpower.

The lesson we should have learned from this past decade, albeit somewhat late, is that aviation has grown into big business and serious business, and that it cannot be run by a few people with ideas. It needs considerable foresight, first-class organization and the elaborate facilities mentioned to get anywhere at all. But we can, and must, find a new formula in aviation by our undoubted engineering ability, always remembering that what still matters is to sell and to produce efficiently.

MARTIN NUCLEAR DEVELOPMENTS

AN "operations management team," headed by Mr. William G. Street, has been formed by the Martin Company, Baltimore, "to push development of a nuclear-powered seaplane."

This formation follows Martin's "systems management" concept under which each project has its own operations manager, who becomes in effect the head of a miniature company, exercising overall control and reporting directly to the most senior executives of the firm.

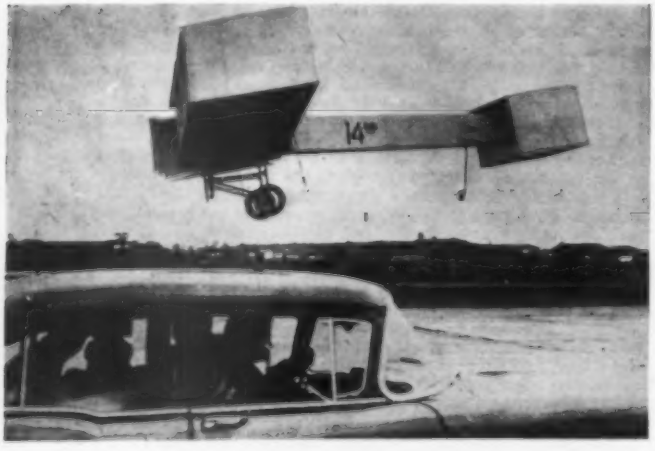
For over three years Martin have been engaged on a design-study, sponsored by the U.S. Navy, for the airframe of a nuclear-powered marine aircraft.

Martin are, of course, responsible for the P6M SeaMaster four-turbojet flying-boat, production models of which have been ordered for the U.S. Navy.

GROUND-LEVEL EJECTION FROM F-102

THE Talco Engineering Company of Hamden, Connecticut, are developing a ground-level seat-ejection catapult for the F-102. In order to eject the pilot to a safe height for parachute deployment while his aircraft is still on the ground, the seat incorporates a rocket booster which is fired by the explosion of the normal ejection cartridge. This method provides continuous thrust which will achieve the necessary altitude without initially overstressing the pilot. The thrust of the rocket is slightly offset in order to eject the pilot in a partly rearward direction, thus moderating the violent deceleration which he would suffer on entering the air-stream.

The Talco company, which specializes in the production of cartridge-activated devices, has set up a large new test installation at North Branford, Conn., ten miles from Hamden. It includes 200-ft and 25-ft horizontal test-tracks, together with complete instrumentation to record thrust, pressure, acceleration and stroke of the units at millisecond intervals. High-speed ciné cameras capable of exposing up to 3,000 frames per second are also installed.



***PROTOTYPE REPLICA:** At Rio de Janeiro, Brazil, in preparation for the 50th anniversary of Alberto Santos-Dumont's pioneer flight in a heavier-than-air machine (the first such flight in Europe) a convincing replica of the "14bis" is tested for airworthiness.*

THE MIGHTY C-132

FURTHER details of the Douglas C-132 turboprop transport for the United States Air Force were recently revealed in Los Angeles. Powered by four Pratt and Whitney T57 two-spool turboprops each rated at 15,000 e.h.p., the C-132 will weigh more than 500,000 lb, one-fifth of which will be the payload for "global range." For 3,500-mile stages an overload payload of 200,000 lb will be possible.

The high-mounted wing will have a high aspect-ratio and acute sweepback. The tail surfaces will also be swept and a long dorsal fin will extend forward along the fuselage. The latter will have a form similar to that of the C-130 and C-133, the section being of the double-bubble type, and the total depth being at least 25ft. There will be 16 wheels in the main landing gear.

This colossal aircraft, which is at present under intensive development at the Douglas plant at Tulsa, Oklahoma, is intended to be the future standard heavy freighter and tanker of the Strategic Air Command and other units of the U.S.A.F. It will certainly be the fastest propeller-driven aircraft ordered into production, since the cruising speed is specified as Mach 0.8 and the maximum speed Mach 0.9.

FORMIDABLE ANTI-SUB. WEAPON

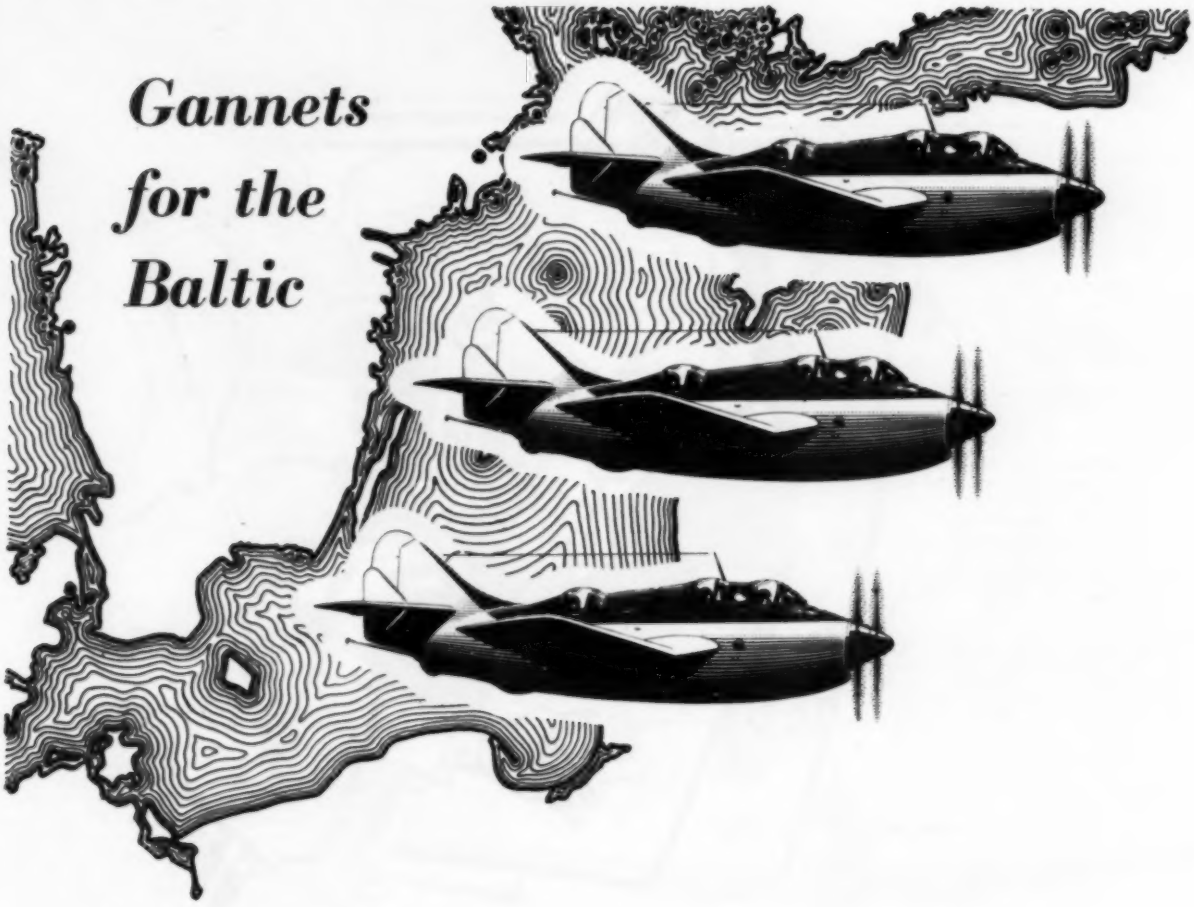
SPEAKING to the Aviation Writers' Association in Washington last week, Vice-Admiral William Davis, U.S. Deputy Chief of Naval Operations, revealed the existence of an atomic anti-submarine weapon which could be set to detonate at a great depth and to be capable of killing submarines "within miles of the point of explosion." He emphasized the word "miles," as distinct from the measurements in feet usually associated with conventional depth-charges. Code-name of the device is "Lulu."

SYCAMORE FOR N.A.E. ICING TESTS

DE-ICING tests involving a Bristol Sycamore helicopter are to be made at the Canadian National Aeronautical Establishment at Uplands Airport, Ottawa. The object is to evaluate the performance of the Goodyear rotor-blade de-icing equipment which is under consideration for the tandem-rotor Bristol 192.

For test purposes, the Sycamore has been fitted with a cyclic electrical power system which operates a series of thermal-electric mats extending along the leading edge of the outer sections of the main rotor blades. Fabricated in moulded rubber sheeting and covered by a stainless steel anti-corrosion sheath, the mats contain eight metal elements which are heated successively by current controlled by a cyclic switch on the rotor hub.

Icing conditions will be simulated by flying the helicopter in the steam cloud from the N.A.E. low-temperature spray rig (as illustrated with a Bell 47 in *Flight* of August 24 last). Power required for the de-icing equipment will be provided by a ground alternator connected to the Sycamore by a trailing lead; eventually a special airborne alternator will be designed.



Gannets for the Baltic

WESTERN GERMANY has indicated the intention to order a unit of anti-submarine Fairey Gannets for its shore based Naval air arm. The Gannet, already in service from the North Sea to Australian waters, will thus soon be seen over the Western Baltic coastal waters—a significant addition to the long list of seas and oceans under Gannet surveillance.

FAIREY

ANTI-SUBMARINE AIRCRAFT
CARRIER-BORNE & SHORE BASED

Gannet

Powered by the Armstrong Siddeley Double Mamba

THE FAIREY AVIATION COMPANY LTD · HAYES · MIDDLESEX
ENGLAND · AUSTRALIA · CANADA

E

Your own four-engined airliner—

the new executive **HERON**

Four-engine security can be had without operating a large and costly aircraft.

For the private owner or the business house, there is a four-engined aircraft of moderate size and remarkable overall economy—an airliner in miniature.

The executive Heron seats 8 passengers in comfort—indeed luxury—and is suitable for stages up to 1500 miles.

The Heron is a de Havilland product throughout, powered by four de Havilland Gipsy engines and de Havilland feathering propellers.

Large numbers of de Havilland multi-engined executive aircraft are operating in the United States and throughout the world.

D E H A V I L L A N D

HATFIELD, HERTFORDSHIRE, ENGLAND

A recent "Flight" picture of a Supermarine Swift F.7, first of a small batch of these machines intended for the development - firing and service-testing of the Fairey Fireflash guided missile. The span is about 3ft greater than that of the Swift F.R.5.

AIRCRAFT INTELLIGENCE

Great Britain

Vickers-Armstrongs Varsity. The recent exclusive *Flight* feature on the Varsity for King Hussein of Jordan has prompted a reader to send the following note: "It is not generally known that this is the second Varsity to be sold to a foreign power. During 1953 a standard production Varsity, WJ900, was converted by the parent company at Hurn Airport for the Swedish Air Force as 82001. To supplement the loss of this aircraft to the Royal Air Force an additional machine was built, this having the serial number XD366. By the time the production of the Varsity had ceased in early 1954 a total of no fewer than 163 aircraft had been built, the type having flown for the first time in July 1949. Besides being used in its intended role with Flying Training Command it is in service with both Transport and Coastal Commands plus No. 116 Squadron, based at Watton."

Martin Mercators in the U.K. Recent correspondence in *Flight* concerning Mercators seen in the United Kingdom lends interest to the news that on October 28 a P4M-1Q Mercator came into Bovingdon and was based there for a few days. It seems that the Mercators seen over this country are based at Port Lyautey, Morocco, and belong to Electronic Counter-measures Squadron Two (VQ-2).

U.S.A.

Hiller X-18. A VTOL aircraft known as the X-18 is to have a Fairchild C-123 fuselage and two Allison T40 turboprops, loaned by the U.S. Navy. The wing will be of new design.

Boeing KB-50. Tankers of this type are to be fitted with two General Electric J47 booster packs, presumably to improve their altitude performance.

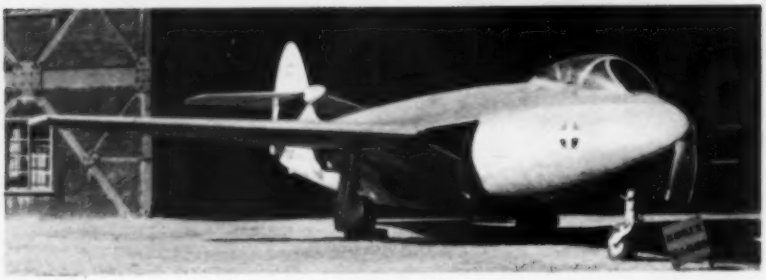
Lockheed F-104A. The first Lockheed F-104A Starfighters are due to pass into operational service early next year. They will be based at west coast airfields.

U.S. Army Requirements. A design competition is to be held next year for an observation helicopter for the U.S. Army costing only about $10,000. Another Army requirement is a fixed-wing machine with a speed between 275 and 300 kt, able to land and take off over a 50ft obstacle within 600ft. It should be available by 1960 and is already the subject of a design competition. The Army also needs a fixed-wing cargo aircraft with a 2½-ton payload, a 200 kt cruising speed, and capable of take-off and landing within 500ft. A similar transport for 4-ton load should have a speed of about 250 kt. The turbine-powered Vertol H-21 is being considered as a possible answer to the "medium cargo" helicopter requirement, and a number of flying cranes for loads of 8 to 15 tons are being studied by the industry for a design competition expected next year. Yet a further requirement is for an "aerial jeep," to weigh 1,000 lb and to carry an equal payload. This should be ready for Army tests by 1959.

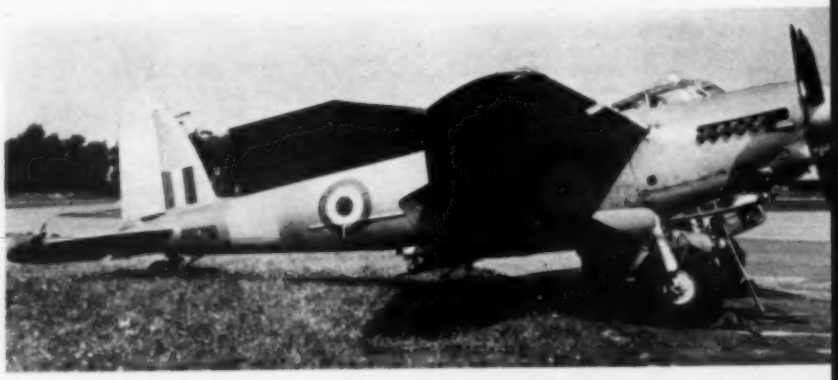
France

Max Holste Broussard. An order for ten Broussards has been placed by the Argentine Government as a result of negotiations handled by the Office Francais d'Exportation, the president of which is General Fay. The production schedule of the Broussard has been scrupulously maintained and the present rate is four a month. To date 325 are on order.

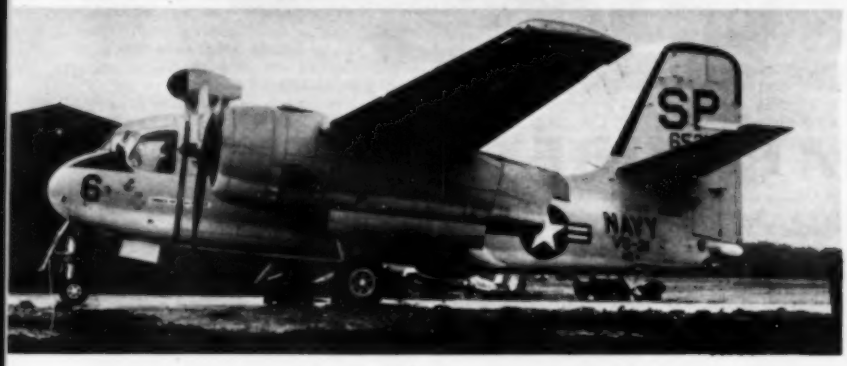
Boisavia B.260 Anjou. Test flights of this light twin continue. The two SNECMA 160 h.p. engines are giving a maximum speed of around 186 m.p.h. and a cruising speed of about 158 m.p.h.



SOMETHING OLD, SOMETHING NEW

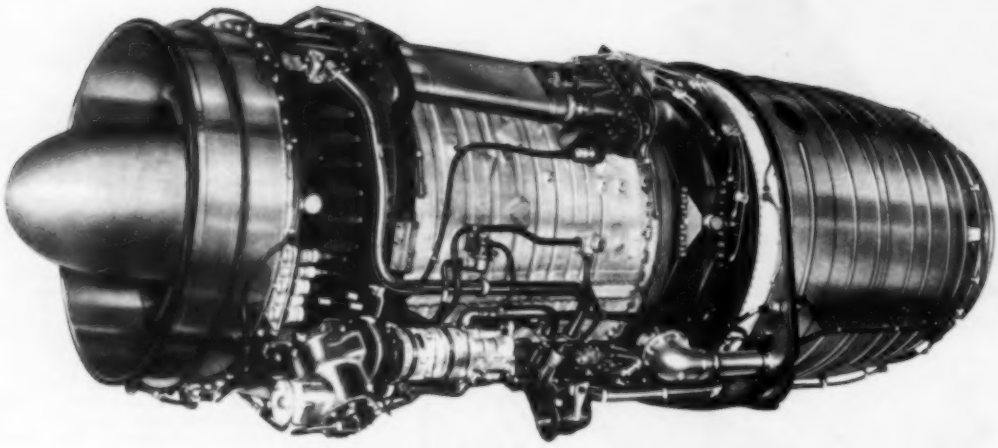


A Curious, but Mainly Topical, Collation of Military and Civil Aeroplanes



IT is not the professional air-to-air photographers alone (their work has been prominently featured in recent issues) who provide the pictorial wherewithal to keep the aircraft of the world in the eye of our readers. We are well served also by many private enthusiasts and picture-agency operators, as this gathering exemplifies.

In the markings of the rising sun is seen, at top left, a handsomely refurbished PBY-6A Catalina amphibian of the Japanese Maritime Self-Defense Force. Below it we have a British curiosity—the Hawker P.1052 fitted with a swept tailplane. Formerly numbered VX272 and now 7174M, this famous prototype is preserved at R.A.F. Station Cardington. The three Mosquitoes, reading down, are a TT.35 target tug, a T.3 operated by Airwork, Ltd., at St. Davids, and—a topical item this—a B.35 of the Israeli Air Force. On this page are two recent and related American visitors. On the left are a Grumman TF-1 Trader transport and an S2F-2 Tracker anti-submarine aircraft. Finally, by way of contrast in piston-engined transports, is the first Douglas DC-7C for B.O.A.C. (a report of its arrival at London Airport appears on page 767) and a D.H. Rapide of Don Everall (Aviation), Ltd.



SAPPHIRE 7

Armstrong Siddeley's Fine Turbojet Further Developed

THE description of the Armstrong Siddeley Sapphire Sa.6 turbojet in *Flight* of January 6 this year included a brief history of the work which led up to its design. At the same time we were able to publish the first photograph of the Sapphire Sa.7, although security restrictions precluded description of little more than was apparent from external inspection. This engine represents a divergent line of development from the Sa.6 and later engines, although all marks of Sapphire have stemmed from the engine carrying the Ministry of Supply rating Metropolitan-Vickers Sa.1—the result of a project contract and an order for prototypes of the Metrovick research project F.9 In 1947, when Metropolitan-Vickers decided to cease production—and, in fact, their entire association with aero engines—this promising early engine was passed over to Armstrong Siddeley Motors, Ltd., and was subsequently redesignated ASSa.1.

Energetic development by the new owners saw the engine pass—at successively higher thrusts—through the Sa.2 stage to the redesigned Sa.3, which foreshadowed the engines that are in production today.

An intermediate stage of development between the Sa.3 engine and the Sa.6—which was produced in considerable numbers before production ceased recently—was the Sa.5. Little can be said about this engine, except that it is neither a direct lineal descendant of the Sa.3 nor a forerunner of the Sa.6. In any organization where pre-production and project research is undertaken, it is inevitable that several lines of development are pursued simultaneously. In the case of a turbojet such as the Sapphire, development may well take place on the compressor, combustion chamber and the turbine simultaneously; as a result, thrusts achieved on test, and type-number designations, overlap and lose their chronological sequence.

The Sa.5 engine may thus be regarded as a development sidestep of the production Sa.3—an engine which passed its second Ministry of Supply type test at 7,590 lb thrust and a specific fuel consumption of 0.909. This represented a considerable improvement over the original MVSa.1, the thrust of which fell short of 7,000 lb. The Sa.6 was a considerable step forward again. By increasing the maximum r.p.m. over the Sa.3 rating the thrust was boosted to 8,300 lb (confirmed by a type test in March 1952) and an s.f.c. of 0.9 was achieved. This engine was again directly developed into the Sa.12, which operated at a higher temperature and had cast turbine blades. This variant of the Sapphire passed a type test in February 1955 at a thrust of 8,500 lb—an indication of the results of steady development of a basic engine type. These engines are identified (with additional Mark number variants) by the series number 100, while the Sa.4, Sa.4/7, Sa.7 and subsequent engines bear 200 series numbers.

The history of the 100 series engine has been outlined at some length in order to relate the subject of this article—the Sapphire ASSa.7—to its predecessors. A fairly major change in thinking and design was made to the ASSa.3 Sapphire in order to pursue development for higher flight speeds, and the first engine of this new branch of the Sapphire family tree was designated the ASSa.4. Subsequently, but also partly concurrently, the Sa.7 was developed from the ASSa.4, with an intermediate type designated Sa.4/7. The type numbers Sa.8 and Sa.9 have been allocated to later Sapphire developments, but information is still restricted.

The principles guiding Armstrong-Siddeley in the design of the Sa.4 were to provide an engine that would be suitable for a high supersonic Mach number at any altitude. It is interesting to trace these tenets through the resultant mechanical design and take stock of the features which had reached the ultimate practical stage in the Sa.3—or, more realistically, in the higher-rated Sa.6.

The firm also undertook to produce, with the Sa.4, an engine that would give a very much greater thrust. They have succeeded in keeping installational changes to a minimum and the new engine may be contained within the dimensional envelope of the Sa.6. Many of the accessories and systems can be repositioned to suit the aircraft engine-bay location and, in particular, the same side-mounting trunnion attachment points are used.

Development of the Sa.4 began immediately after the first run in July 1952, when the maximum r.p.m. were increased and the engine redesignated Sa.4/7. In this form a 25-hr special-category test was passed in February 1953 and the engine was subsequently further developed (with a turbine design change) to become the Sa.7, which first ran in February 1954. By midsummer 1954 a 150-hr test had been completed, and in October a successful type test at 10,200 lb thrust was achieved. This represented more than a 25 per cent increase over the Sa.6 output for about the same dry weight. The engine first flew in the development Canberra WD 933 in September 1954.

To meet the criteria that had been laid down for the Sa.4, both thermal and volumetric improvements in the Sa.3 design were required. Although the overall dimensions remained unchanged, the new engine included a re-profiled compressor and the substitution of ferrous components for most of those previously made from light alloy. The compressor intake was enlarged to the outside diameter of the combustion chamber and the compressor hub was accordingly also re-profiled aft of the nose bullet. These changes have given the 200 series engines a distinctive external appearance; they may be easily identified by the tapering, and slightly shorter, compressor casing. The mass flow has been considerably increased.

As previous compressor casings had been cast in L.51 aluminium alloy, the new casing—which was designed to withstand higher temperatures—involved a change of material. It was originally envisaged that a spheroidal-graphite iron casting would be used; but this was a rather complicated component to make, so a fabricated mild-steel casing was manufactured by Armstrong Siddeley during the period in which the casting was being produced. Heavy-gauge steel plate was bent into two half-cones; flanges were welded on and machined so that the halves could be bolted together and machined externally; bosses and end flanges were added; and the complete assembly was profiled internally to reduce the wall thickness to between 0.08in and 0.1in. Locating grooves were also machined into the periphery of each half to accommodate the stator blades. The resultant casing was very satisfactory and comparable in weight and stiffness with a light-alloy structure; but although it provided an interesting essay in workshop technique it could not be expected to provide more than a useful development expedient.

For ground running of the prototype engine a ribbed light-alloy compressor casing was used. Although this was not expected to be satisfactory for the temperatures reached at high supersonic flight speeds, it was later realized that such performance would not be required for some time. Consequently production engines use light alloy casings of simpler external form than the prototype.

Engineering of the stator blade assembly originally followed the technique employed in the Armstrong Siddeley Viper, where the outer ends of the blades were brazed into four 90-degree segments and dovetailed to fit and lock into corresponding slots in the stator casing. The inner end of each blade had a pip machined onto it

which registered with a hole in a light channel segment and was then silver-solder brazed by the induction process. In the Sapphire, however, this arrangement proved unsatisfactory; the blades suffered from cracking of the brazed joints. The solution that was eventually found consisted of marrying the blade securely to its base; in practice an integrally cast part was used in conjuncton with the shroud strip around the inner tips of the blades. Although this arrangement was satisfactory, the reversion to a light-alloy casing rendered this particular piece of development redundant, as the proven Sa.6 stator blade mounting (in which the blades were carried in diagonal dovetail slots machined into R.R.58 alloy half carrier rings) was again adopted. The first seven rows of stator blades are now fitted with segmented shroud rings—brass on the first two rows and steel on the remaining five. The shrouds run very close to the compressor and are lipped to form an inter-stage seal. The remaining rows of blades are unshrouded.

The mechanical design of the compressor was both simplified and improved with the introduction of a mild-steel compressor drum to carry the blade-retaining discs. The seven stepped diameters of the earlier aluminium alloy drum have been replaced by a straight-sided tube upon which the discs are free to slide, and the drive between each disc is transmitted by a series of driving rings which are shrunk onto the drum with a light interference fit. Each ring is threaded on its outside diameter to accommodate an extractor tool. Machined on to the compressor drum at the fifth-stage location are a series of driving dogs from which torque is transmitted fore and aft into the various discs by Curvic-form teeth on the driving rings.

A departure from previous practice is that, apart from the stiff first-stage disc and the reinforced twin discs of the triangulated thirteenth-stage structure, thin discs with little inherent diaphragm stiffness are used. Rigidity of the assembly is ensured by introducing rotating shrouds spigoted into position between the front discs, and further shrouds held in place by the blade platforms on those discs (stages 8 to 13) where the compressor blades are riveted into place. The complete assembly is then given an axial nip by bolting-up the front and rear extension shafts (which carry the front and centre bearings) against rings which are flat on one side and mesh with the Curvic couplings of the first and last discs on the other. These rings are finally machined just prior to assembly in order to control the nip in relation to the accumulated tolerances along the length of the assembly.

The compressor blades on the 200 series engines are similar in form to scaled-up blades of the Series 100 engines, and are of all-steel construction—heat-treated S.62 steel stampings are used throughout. Initial running with these blades disclosed a root weakness caused by flutter-induced fatigue in the stalled flow to which the early stages are subjected. This, combined with the difficulties with the stator blades which have already been mentioned, led Armstrong Siddeley to tackle (as one line of development) the blade-fatigue problem at its source.

To do so it was necessary to reduce the intake area of the compressor for starting and at low r.p.m. This was achieved by means of an ingenious system similar to that which was used by Curtiss-Wright on the J65 version of the Sapphire. This consisted of three petal-ramps between each support strut, operated by means of small hydraulic jacks and controlled by an automatic governor-operated valve. Normally the flaps stand out into the airstream and considerably reduce the intake area available, but operation of the governor caused them to lie flush with the intake cone. Strain-gauging of the blades (a difficult task when root stresses require to be measured; the finite length of the gauge prevents accurate spot measurements being made) showed that an immediate stress-reduction resulted. Engine handling and response also received benefits at low running speeds.

Meanwhile, development work on the blades had continued and it was found possible to achieve satisfactory results by stiffening the blade roots without altering the serrated-root attachment of the critical blades to the discs. During development, the stagger angle on the blades was changed and the tip clearances decreased. The same practical result having been achieved in two ways, it remained for the firm to decide if anything useful was to be gained by continuing with the area-changing ramps. As it was a considerably simpler solution, the choice fell upon the stiffened blades, which were successfully tested by running the engine for 120 hr at increasing increments of r.p.m. through the critical vibration-frequency range. This test, which is extremely severe since it represents continuous running in a condition that is usually avoided, is regarded by Armstrong Siddeley as representing thousands of hours of testing at working r.p.m.

Drive to the compressor assembly is transmitted through the main S.96 steel turbine shaft. An advantage of the change which was made from air-cooled to oil-cooled bearings—to which further reference will be made later—is that the bearings could be mounted directly on the shaft, enabling lipped outer bearing tracks to be used; the inner tracks can be left in position while the shaft is balanced. A noteworthy change from the Sapphire Sa.6 is that, in order to withstand the increased thrust, the single front bearing (on the compressor drum extension shaft) has been replaced by a matched pair of ball thrust races.

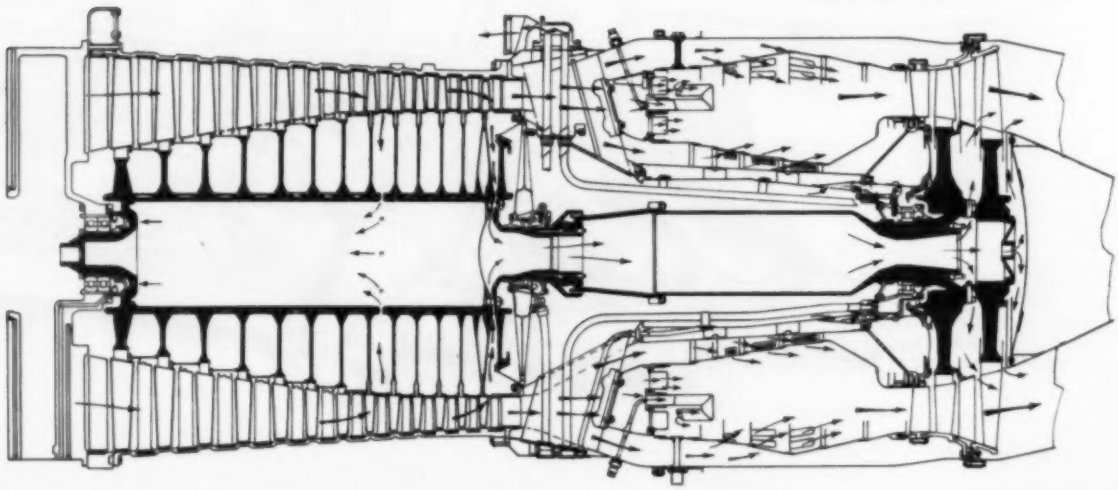
Although slight differences in detail design between the centre bearing arrangements of the Sa.6 and the Sa.7 have been made, the h.t. steel spherical bearing remains principally unchanged. It has been designed to permit slight axial malalignment and is held in tension between the rearward pull of the turbine and the residual forward thrust of the compressor and the thrust equalizer. The equalizer disc is subject to thirteenth-stage air on its forward face and is opposed by air of substantially atmospheric pressure behind. Radial loads are supported by roller bearings at the centre and rear of the shaft; the rear bearing is carried in an annular mild-steel housing bolted on to the centre section.

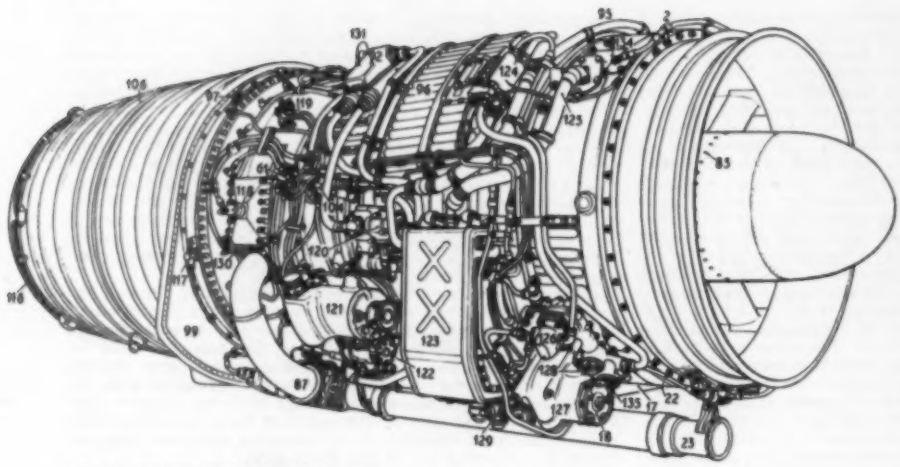
Fabricated for Armstrong Siddeley by Briggs or Sankeys from mild- or stainless-steel sheet, the load bearing centre section attached to the compressor casing at the front and to the combustion chamber at the rear consists of inner- and outer-cone walls which are located relative to each other by ten short streamline struts. Onto the forward end is bolted the fabricated diaphragm carrying the centre bearing, and a mild- or stainless-steel sheet conical extension is bolted to the rear end. The combustion chamber and back plate is located by ten bayonet-type pins and locked by bolting two of these pins through into the diffuser. This method of attachment allows the chamber anti-rotation bracket of the Sa.6 to be deleted.

Carried from the centre section struts, the diffuser is longer and more definite than that used on the Sa.6 and divides the air downstream of the compressor into combustion and dilution airflows. The fuel vaporizing tubes are of similar design to those used previously but it has been found possible to reduce the number from 36 to 24, reducing both weight and complexity.

Various difficulties were encountered in the development of the Sa.7 turbine. The Sa.4 was the first of the Sapphire series to use a shrouded turbine, an innovation that proved satisfactory until this engine (as the Sa.4/7) was run at higher r.p.m.—mainly by adjusting the fuel flow and resetting the inlet guide vanes. In this configuration, the fundamentally incorrect rating of the turbine at the higher rotational speeds gave rise to several fatigue failures of the rotor blades. To combat this tendency, the robust blade shrouds were welded together in pairs—an expedient that, although successful on the A-S Mamba engine, proved unsuitable on the Sapphire. Some experiments were then conducted with

Airflow paths are shown in this section diagram of the Sapphire Sa.7. High-pressure regions are denoted by heavier arrows.



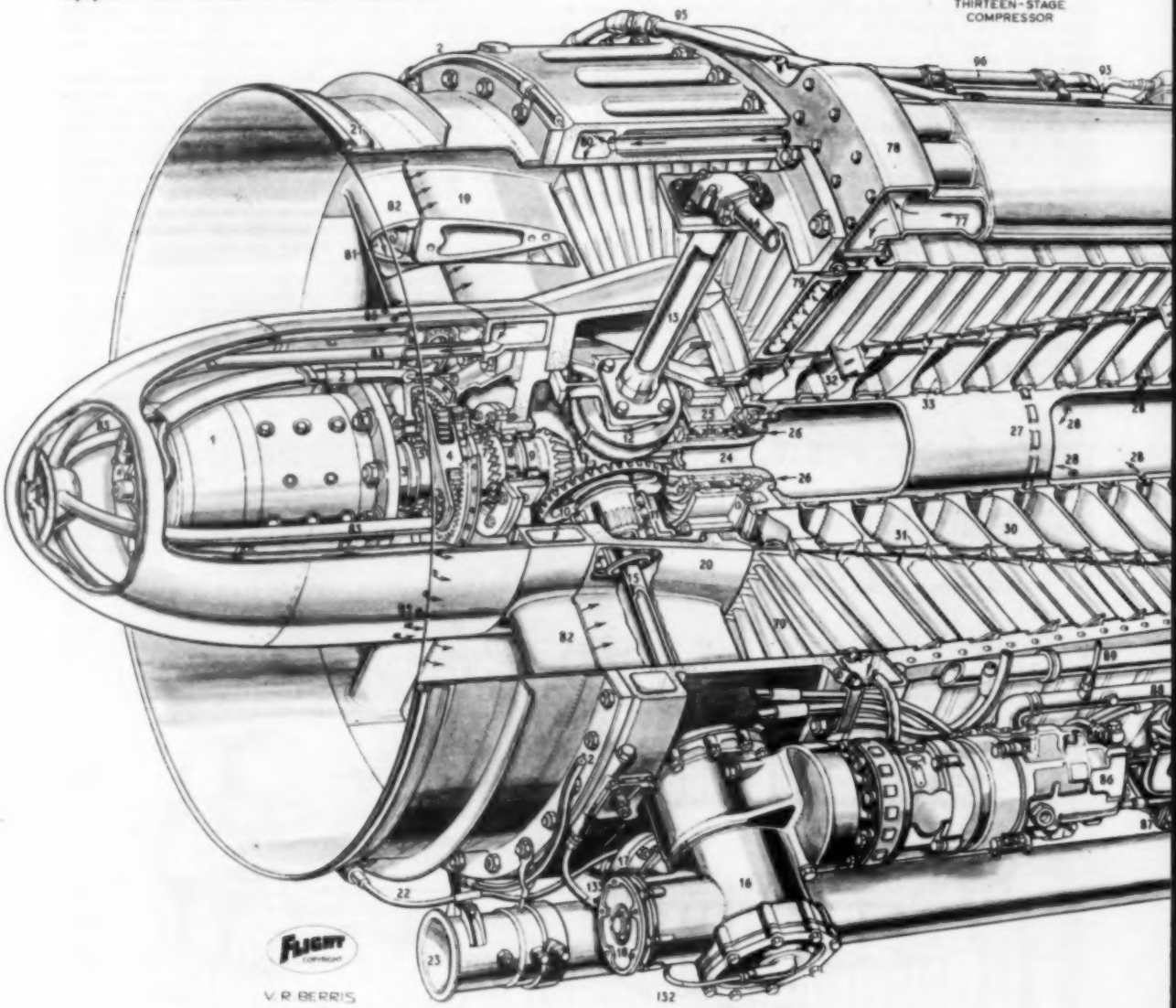


1-7 *Electric starter details:—*
1 Motor
2 Supply leads
3 Limiting-torque clutch
4 Epicyclic reduction gearbox
5 Satellite-carrier roller bearing
6 Gearbox thrust bearing
7 Driving dogs
8 Compressor extension shaft thrust bearing
9 Accessory-driving pinion and bearing
10 Accessory bevel gear
11 Roller-type free-wheel lock
12 Centrifugal oil/air separator driven from (10)
13 Separator stack-pipe
14 Overboard breather pipe
15 Accessory drive shaft from (10)
16 Fuel pump and accessory-drive bevel box
17 Accessory-drive cross-shaft between port and starboard bevel boxes
18 Accessory-drive Layrub coupling flanges
19 Intake casing strut
20 Intake casing inner cone
21 Intake extension rubber seal
22 Oil-pressure transmitter pipe
23 Cabin-heating trunk to airframe
24 Compressor front mainshaft
25 Matched twin Duplex thrust bearings
26 Air bleed holes for pressurizing front-bearing oil seal

SAPPHIRE 7 . . .

This "Flight" drawing shows a typical Armstrong Siddeley 200 series engine of ASSa.7 rating, with equipment suitable for a bomber installation.

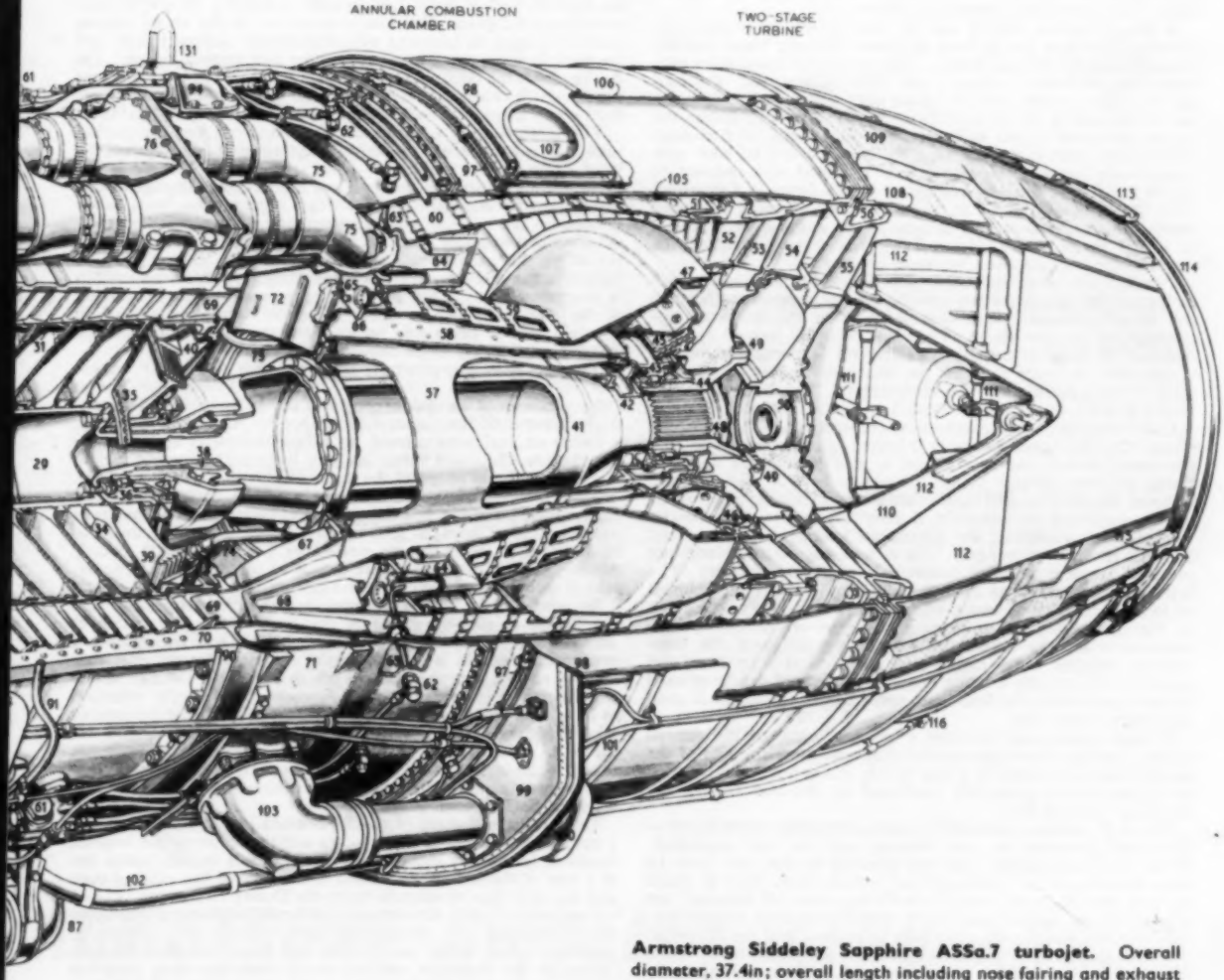
THIRTEEN-STAGE COMPRESSOR



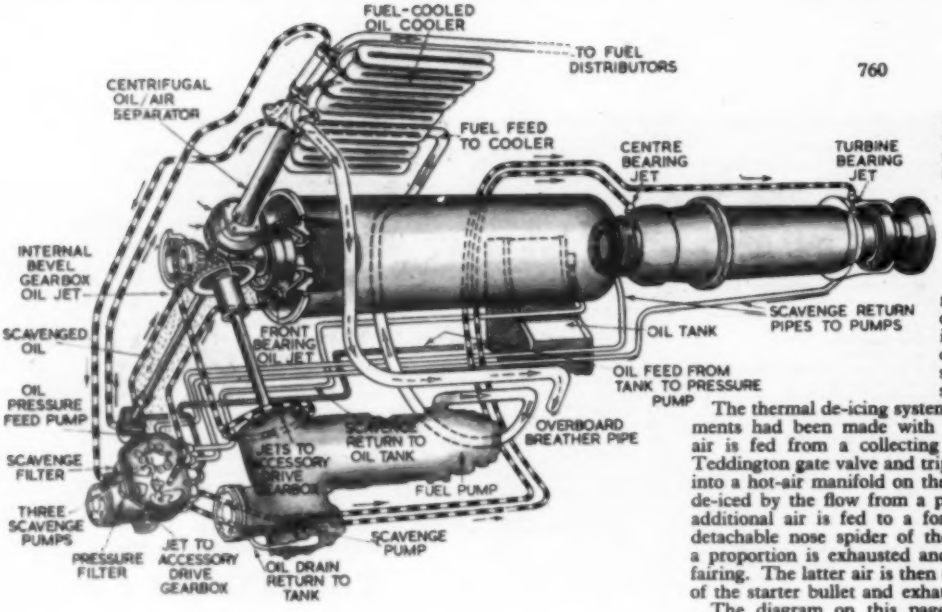
FLIGHT COPYRIGHT

V. R. BERRIS

27 Compressor disc driving-dogs
28 Eighth-stage air bleed holes to pressurize front-bearing oil seal
29 Blanking diaphragm plate
30 Compressor rotor disc
31 Rotating shrouds (stages 1-12)
32 Stator shroud rings (stages 1-7)
33 Curvic coupling ring
34 Triangulated 13th-stage rotor disc
35 Alternate coupling teeth omitted to allow passage of 13th-stage cooling air for turbine
36 Centre roller bearing
37 Centre-bearing-scroll oil seal
38 Spherical bearing
39 Thrust equalizer labyrinth seal and disc
40 Centre-bearing diaphragm
41 Turbine mainshaft
42 Rear-bearing-scroll oil seal
43 Rear roller bearing
44 Rear-bearing-scroll oil seal
45 Turbine labyrinth seal
46 Turbine diaphragm
47 Inner flame-tube seal ring
48 Turbine lock-nut
49 Taper pins mounting turbine discs to stub-shaft
50 Turbine blanking plug
51 Outer flame-tube seal ring
52 First-stage turbine nozzle blades
53 First-stage turbine rotor blades
54 Second-stage turbine nozzle blades
55 Second-stage turbine rotor blades
56 Torque-ring dogs
57 Centre-section conical extension
58 Heat shield
59 Inner flame-tube dilution ports
60 Outer flame-tube with corrugated film-cooling strip
61 Fuel distributors
62 Fuel feed pipes
63 Burner pipes
64 Primary air tube
65 Secondary air tube
66 Combustion chamber back-plate
67 Centre-section aerofoil strut
68 Diffuser entry to combustion chamber
69 Compressor outlet straightener vanes
70 Stator case joint
71 Centre section
72 Stiffeners and diffuser attachment in aerofoil strut
73 Rear-bearing vent pipe
74 Rear-bearing scavenge pipe
75 De-icing bleed
76 Teddington gate valve
77 Triple feed pipe
78 De-icing hot-air manifold
79 Hollow de-iced fixed inlet guide vanes
80 Manifold to transfer hot air for de-icing spider and bullet
81 Passage for hot air from (80)
82 De-icing air outlet from spider
83 De-icing air feed pipes for bullet
84 Metering orifice for bullet de-icing air
85 Outlet holes for bullet de-icing air
86 Fuel pump
87 Cabin-heating air bleed with Teddington gate valve
88 Fuel-pump outlet pipe
89 Fuel pressure transmitter pipe
90 Distributor drain pipe
91 Graviner fire-extinguisher pipe
92 Flowmeter
93 Cooler outlet to P.I.V. fuel pipe
94 Centre and rear bearing vent connector
95 Centre and rear bearing vent pipe
96 Fuel-cooled oil cooler
97 Primer ring
98 Firewall seal (silicone-rubber seal covered with asbestos cloth)
99 Firewall
100 Vapour outlet pipe from centre section
101 P_4 pipe to fuel pump
102 Collector-box drain
103 Centre-section breather valve
104 Priming solenoid valve
105 Combustion chamber outer casing
106 Combustion chamber and exhaust-cone heat shield
107 Combustion chamber exhaust-cone and jet-pipe near cooling-air inlet
108 Exhaust cone outer skin
109 Insulating blanket
110 Exhaust-cone bullet
111 Exhaust-cone stay tubes
112 Exhaust-cone aerofoils
113 Heat shroud ring-joint to jet-pipe
114 Exhaust-cone rear flange incorporating piston-ring seal
115 Conduit for leads to Graviner fire detectors
116 Distributor drain connection to exhaust cone
117 Lodge high-energy igniter
118 Engine-mounting trunnion
119 Oil-feed connections for centre and rear bearings
120 Air-fuel ratio control
121 Low-pressure fuel filter
122 Barometric flow control
123 Oil tank (stainless steel)
124 Inlet and outlet to fuel-cooled oil cooler
125 Oil-tank vent connection to intake casing
126 Oil-pressure feed pump
127 Cross-shaft bevel box
128 Scavenge filter cap
129 Oil tank sump
130 Compressor outlet (P_3) pressure tapping, for A/F.R.C. (120)
131 Steady trunnion
132 Oil drain pipe to (123)
133 Air-intake pressure tapping for flow control
134 Starter lead terminal
135 Pressure filter cap



Armstrong Siddeley Sapphire ASSa.7 turbojet. Overall diameter, 37.4in; overall length including nose fairing and exhaust cone, 132in; dry weight (including anti-icing, turbo-starter, high-energy igniters and oil tank), 3,075 lb; rated thrust, 11,000 lb; specific fuel consumption, 0.89 at maximum sea-level thrust.



Noteworthy features of the Sa.7 lubrication system are oil-cooled bearings and a Delaney-Gallay heat-exchanger. Reasons for this departure from earlier practice are discussed in the text.

Some minor mechanical improvements have been made to the exhaust cone assembly. The fairings over the stay tubes have been divorced from the outer casing and sole-plates are used to reinforce the stay-tube attachments to the cone.

The thermal de-icing system was perfected after various experiments had been made with electric de-icing. Thirteenth-stage air is fed from a collecting annulus through a three-position Teddington gate valve and triple feed pipe (muffed for insulation) into a hot-air manifold on the casing. The inlet guide vanes are de-iced by the flow from a perforated tube in each vane, while additional air is fed to a forward manifold and thence to the detachable nose spider of the four support struts, from where a proportion is exhausted and the remainder is fed to the nose fairing. The latter air is then discharged between the double skin of the starter bullet and exhausted through peripheral holes.

The diagram on this page illustrates the oil system, which represents a considerable departure from Sa.6 practice. On that engine the bearings were air-cooled and lubricated by a microfeed pump supplying half-a-pint per hour. It was appreciated in the design of the Sa.7 that at high altitudes air cooling would be inadequate, and a flood feed system delivering 30 gal/hr was accordingly adopted. The total-loss system of the earlier engine could no longer be tolerated with this greatly increased flow, and the Sa.7 incorporates a scavenge return and venting system. Oil leakage from the centre and rear bearings is checked by protecting scrolls which retain the oil by the slight pressure-difference of air to oil across them. A valve maintains this pressure above 2 lb/sq in.

The front bearing is protected by a labyrinth and piston-ring seals and is pressurized by eighth-stage air contained within the rotor drum by the diaphragm plate at the rear. The air is fed back into the compressor inlet. Since there is some leakage of this pressurized air into the oil a centrifugal separator has been incorporated in the oil-mist-lubricated accessory drive gearbox. The double-sided impeller flings off the oil centrifugally and breathes the oil up the central stack and overboard *via* a lead-off pipe. A feature of the accessory gearbox is the wedge-type freewheel which is incorporated in the fuel pump drive to prevent counter-rotation of the engine. This can occur when the second engine of an installed pair is being run on its own; the airflow through the inactive engine may cause abnormal clockwise rotation.

The fuel system is generally similar to that of the Sa.6, except that increased flows are required from the Dowty fuel pump. Other elements of the system consist of an l-p. fuel filter, a Hobson-made barometric flow control developed by Armstrong Siddeley, a Lucas air/fuel ratio control, an Elliott flowmeter and the flow distributors. Solenoid valves are also included to control fuel to the primary spray ring and the six starting spray-jets.

Two versions of starter are used with the Sa.7 engine. For fighter installations, a B.T-H. iso-propyl-nitrate turbine starter is used because of its rapid spin-up advantages; engines destined to be installed in bombers are started by a Rotax C.6805 electric motor. In each case the starter torque to the mainshaft is transmitted through an epicyclic reduction gearbox.

In conclusion, it should be mentioned that powers greater than the 11,000 lb take-off rating of the Sa.7 will be obtainable at altitude with a limited reheat system. This will incorporate a two-position nozzle (a row of Plessey electric actuators operating a series of overlapping segments which provide a circular nozzle when open or closed). It was Armstrong-Siddeley's intention to develop a system for the Sa.6 giving a 25 per cent increase in take-off thrust and then to follow up with a similar scheme for the Sa.4. This reheat thrust would have represented the maximum thrust increase that could have been obtained without an increase of jet-pipe diameter and was in fact achieved on a test-bed run with the Sa.3 system.

Current development of the Sa.7 reheat is aimed at producing a simple system giving 12-per-cent additional thrust for engines intended for fighter applications. Briefly, this system makes use of a row of flame-holders located at the rear of the exhaust cone and the spill flow at altitude from the Dowty fuel pump.

Simple and light, Armstrong-Siddeley's Sapphire is producing—in developed and production form—thrusts that would be creditable from other much later and more complex designs. Although the Sapphire concept stems from the early post-war years, continuous development of the engine has resulted in a current production thrust of 11,000 lb—with the possibility of more to come.

SAPPHIRE 7. . .

the fairings removed from the quadruple rear struts in the exhaust cone. This provided a temporary answer.

A flared turbine (which can be seen in the large cut-away drawing) was then put in hand to reduce the exit Mach number and diminish the exhaust losses. The new design had blades with individual platforms to form a shrouded turbine, and labyrinth tip seals were incorporated to reduce the gas leakage and increase the overall engine thrust and efficiency. In this configuration the engine produced 11,000 lb thrust, but, as a result of first-stage blade creep, had to be de-rated by lowering the turbine inlet temperature again. The thrust then obtained was reduced to 10,200 lb. A type test was completed at this figure in September 1954. After modifications to the combustion chamber had been made, the shrouded-turbine design passed a 150-hour type test at 10,500 lb thrust in March 1953; but this approached the temperature limit imposed by creep troubles.

Development meanwhile had been devoted to an unshrouded-turbine design which had considerably greater temperature latitude and which suffered insignificant losses from the increased tip-clearance of the open blades. The blade materials were changed to Nimonic 90 forgings on the first row and Nimonic 80A on the second row, in order to resist the increased thermal shock that resulted from the higher inlet temperature. This design enabled 11,000 lb static thrust to be obtained on test in February 1955.

Consideration of the mechanical construction of the turbine reveals that the stator assembly is bolted to the rear shroud ring mounted between the rear flange of the combustion chamber casing and the exhaust cone. To ensure correct axial location between the turbine and nozzle blades an adjusting ring, which can be machined on assembly, is provided between the flanges. The method of reacting the gas torque-loading by a peripheral dog-ring remains unchanged. The second-stage nozzle blades are precision castings and are assembled in groups of eight. The first-stage blades (cast in Jessops G.39 alloy) have pips machined on to their inner ends which register with a sealing ring located on the conical support projecting from the centre section. To compensate for the differential thermal expansion of the combustion chamber outer casing and the conical support as the engine warms up, the locating dogs have a limited degree of axial freedom permitting the first-stage stator blades to slide back until they meet a stop ring.

A large piston-ring provides a gas seal between the conical support and the first-stage carrier ring; and the blade tips of the second stage are riveted to a ring which acts as a gas seal between the blades and a projection machined on the rear face of the first-stage turbine disc.

The S.96 turbine stub-shaft is now internally splined and is interposed between the rear bearing and the rear mainshaft. Where the Sa.6 turbine disc was attached to the stub shaft by taper dowels, the Sa.7 front and rear turbine discs (both of which are now manufactured from Firth-Vickers Rex 448 forgings) are spigoted to the outside and inside of the stub shaft respectively. The rear disc has clearance between its register and the stub shaft when the engine is cold; the 24 taper pins in reamed holes which bolt the assembly together accommodate the differential expansion which occurs. Intermediate holes between the turbine discs and a metering plug in the rear of the second disc hub are drilled to pass thirteenth-stage cooling air to the faces of the discs.

Many of the world's most powerful fighting aircraft are powered by Armstrong Siddeley aero engines

SAPPHIRE

1 HAWKER HUNTER
2 GLOSTER JAVELIN
3 HANDLEY PAGE VICTOR
4 ENGLISH ELECTRIC P.1 (PROTOTYPES)
5 P.16 (SWITZERLAND)
6 SNCASO VAUTOUR (FRANCE)

J.65 SAPPHIRE

7 REPUBLIC THUNDERSTREAK F84F (U.S.A.)
8 REPUBLIC THUNDERFLASH RF-84F (U.S.A.)
9 MARTIN B.57 (U.S.A.)
10 NORTH AMERICAN FJ-4 FURY (U.S.A.)
11 GRUMMAN F.11F-1 (U.S.A.)
12 DOUGLAS A4D-1 SKYHAWK (U.S.A.)
13 LOCKHEED F-104 (U.S.A.)

VIPER

14 MACCHI M.B.326 (ITALY)
15 SNCASO TRIDENT (FRANCE)
16 HUNTING-PERCIVAL JET-PROVOST
17 IKARUS G.A. AIRCRAFT (YUGOSLAVIA)
18 JINDIVIK PILOTLESS TARGET AIRCRAFT
19 DASSAULT MIRAGE M.D.550 (FRANCE)

MAMBA

20 BREGUET VULTUR (FRANCE)
21 SHORT SEAMEW

DOUBLE MAMBA

22 FAIREY GANNET

PYTHON

23 WESTLAND WYVERN

ARMSTRONG SIDDELEY AERO ENGINES

COVENTRY & BROCKWORTH

Members of the Hawker Siddeley Group

Their thoughts in the sky, their feet on the ground, aircrew blend courage with careful skill.

Per ardua . . . ad astra. *It is not easy to fly with the R.A.F., to lead others, to shoulder great responsibilities while still young. But in the lasting satisfaction of this immensely worthwhile career . . .*

great effort finds great reward

A young man's dream may dwell on flying — on the exhilarating challenge in the airy spaces of sky. His commonsense tends to call him back to earth — to consider the future and the building of a career.

Feet on the ground

In the Royal Air Force today you can satisfy both these demands—and the new appointment of Air Electronics Officers means more can now fly. These highly skilled men are trained to be responsible for all the electronic devices in the new V-bombers. But aircrew are much more than flyers. They are often seconded for other important work in Britain and abroad. Training others, international liaison, aircraft development — these are but some of the jobs that may come your way. And responsibility grows fast. You can be a Group Captain while in your early forties, responsible for perhaps 1,500 men and several squadrons of modern aircraft. Beyond that? There is no limit. Quality counts in the R.A.F. and there will always be room at the top for good men.

A sure future — good pay

You can join the R.A.F. through the Direct Commission Scheme, confident of a permanent career right up to pension age. Or you can choose a twelve year engagement, with the option of leaving after eight. If you leave after 12 years you take back to civilian life a tax-free gratuity of £4,000! Whichever you choose the pay is good. At the new rates, a Flight Lieutenant of 25 for instance, can draw, with full allowances, about £1,500 a year.

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You must be between 17½ and 26 and absolutely fit. You must have General Certificate of Education or Scottish Leaving Certificate or their equivalents. You must be able to lead others, and you must have aptitude as well as enthusiasm for flying. If you feel you have all these qualities, write at once for details of the Schemes of entry to the Air Ministry (F.R.305a). Adastral House, London, W.C.1. Give date of birth and educational qualifications.

RESPONSIBILITY To fly with the R.A.F. is to work with the most dependable men in the world, confident and well qualified for each of the many calls on their skill and initiative.

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The Royal Air Force
Flying ... and a career

$$\sum_{q=1}^{q=6} A_{pq}(\ddot{X}_q) + (B_{pq}V + D_{pq})(\dot{X}_q) + (C_{pq}V^2 + E_{pq})(X_q) = 0 \text{ (or } F_p(t))$$

where p runs from 1 (for Degree 1) to 6 (for Degree 6)

A = *Structural and Aerodynamic Inertia*
B = *Aerodynamic Damping*
C = *Aerodynamic Stiffness*
D = *Structural Damping*
E = *Structural Stiffness*
F = *External Force*
$\ddot{X}$ = *Acceleration*
$\dot{X}$ = *Velocity*
X = *Displacement*
V = *Velocity Parameter*
t = *Time*

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The Flutter Simulator is only one of the advanced devices in use at Bristol today, devices needing highly skilled technologists and technicians to design, construct and operate them. If you are interested in this and similar work, apply for fuller details to Mr P A Tobin, Bristol Aircraft Limited, Filton House, Bristol.

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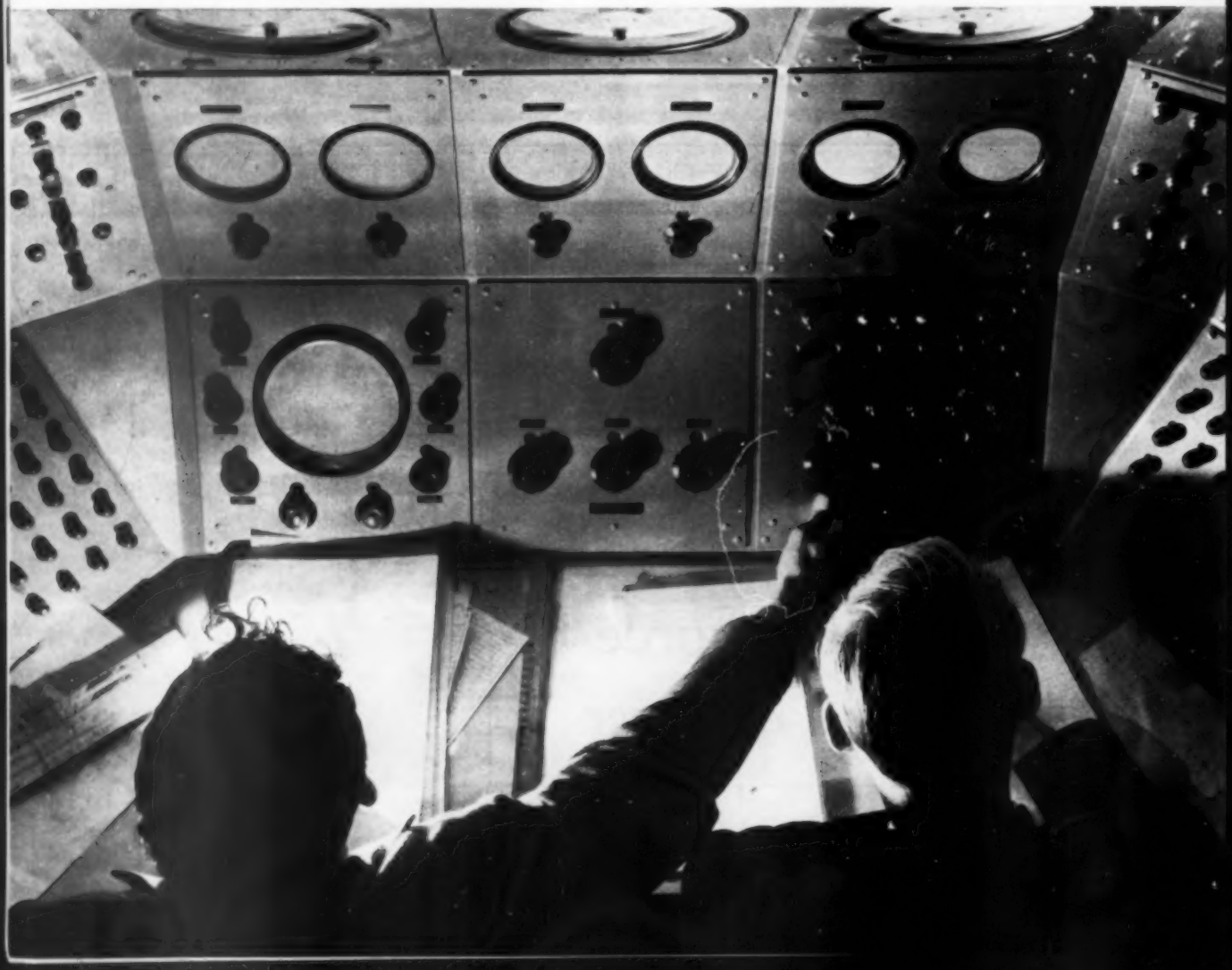

SEA, LAND AND AIR

The Development of Air Forces and their Relationships With Other Services

By L. F. E. COOMBS

HAS modern scientific progress made obsolescent the long-established practice of maintaining armed forces as three separate Services—navy, army and air force? Implications of such a question are discussed in this article, which is certain to arouse controversy.

THE advent of new weapons, particularly of the airborne kind, suggests that it may be advantageous to take another look at the overall concept of a nation's military forces, with the emphasis on air forces. At the same time one fully realizes that such a subject can lead to incessant and sometimes nebulous argument. But the temptation to plan and suggest the rearrangement of things outside one's power is always present; therefore, in full knowledge of the possible consequences of such action an attempt is made here to discuss the type and number of air forces which some nations have, or might have, adopted.

An air force is a costly item to include within a nation's budget, however rich that nation may be in dollars or oil. The needs of the soldier are essentially simple. If he is an Asiatic he needs only food and weapons. If he is recruited from more sophisticated countries then he usually requires also interesting food, transport and entertainment. Unfortunately, the aeroplane and its supporting facilities cut across military simplicity, thereby introducing the need for a self-contained air force.

Although at a very much higher level of complexity, the aeroplane (depending on its type and mission) is comparable with the soldier in that there is a wide possible difference in the amount of supporting facilities which it requires. If we include the simple one-man jet helicopters now being developed in the United States we have a basic measure of complexity, both logistically and operationally. At the other end of the scale is the atomic-bomb-carrying jet bomber, which relies on the support of an extensive array of ground-based facilities and is, therefore, most dependent on "outside" organizations. In contrast, the one-man helicopter is being designed to operate from the tailboard of a Jeep.

The foregoing is, perhaps, a simplification of the problem, for when we consider certain South American countries which have unlimited natural resources for sale we find that their air forces are equipped with Hunters and Canberras, both of which are expensive and complex pieces of machinery to operate. Possibly the South American countries are unrepresentative, for there is a wide gap between 100 per cent squadron availability and the "paper" strength of 100 jet bombers.

Allied with the problems of type of aircraft are the very involved problems of "terms of reference" of an air force, and whether or not it should be independent or owned and operated by a senior Service. As will be seen, some air forces have been both independent and dependent at the same time and also subject to the authority of one or more senior Services. The Royal Air Force has been used as the foundation of this article because, with its associated arms, it formed the first large-scale air Service (R.A.F. is intended to include the R.N.A.S. and the R.F.C.). At the same time the R.A.F. can claim a longer period of active service than any other air force.

On examining a list of the world's air forces it will be seen that they can be roughly grouped under three headings: independent or "equal status"; dependent forces; and "private" forces. The principal examples of the independent air forces are the R.A.F. and the U.S.A.F.; both exercise the utmost independence, as exemplified by their "private" navies and armies. A further definition of "independent" is an air force which has equal status within the ministries of a government; as an example both the R.A.F. and the U.S.A.F. are represented on the Chiefs of Staff committees of their respective countries, and each has a secretariat comparable with those of the Navy and the Army.

Dependent air forces are those which comprise an air-arm or corps of either the navy or the army, such as the R.N.A.S., R.F.C., F.A.A., U.S.A.A.C., U.S.A.A.F., U.S.M.A.C., and the present U.S. Army Air Corps; the last is not a "direct" descendant of the U.S.A.A.C. of pre-1942, but essentially a "new growth"—always in danger of excessive pruning by the U.S.A.F.

"Private" air forces can best be defined as those which are established as specific arms independently of other forces which might provide the same military functions. Owing to operational requirements connected with availability—such as the need to be always on hand to provide guaranteed air operations—it is sometimes necessary to provide private air forces. As an example, it is conceivable that a military force, not necessarily an air force, might need helicopters for transport of supplies over a mountainous region during a particular campaign. If the nation's air force had no helicopters, or was too busy, then the force might be supplied with what was in effect a private air force directly under the operational and logistical control of the force commander. Of course, eventually private air forces grow into air corps and, as in the case of the R.A.F. and U.S.A.F., into independent forces.

Before there were any air forces there were only two military services to be found in the majority of countries—a navy and an army. In Britain the Royal Navy became the senior Service despite the fact that it was not the senior of the Army by length of service; only by the exercising of a healthy independence of governments and by confusing the issue through having a combined naval ministry and naval staff did it acquire its seniority. It even tended to stand aside from the Crown; in contrast, the army kept a close link with the Sovereign through the royal bodyguard and the courtiers.

Until the establishment of the Army as a homogeneous force there were a number of "private" armies to give precedent for private air forces, such as the Honourable Artillery Company and the Royal Marines. The latter was gradually built up by the Admiralty from the infantry regiments borrowed from the Army. In addition there were the private forces maintained by the Hudson's Bay Company and the East India Company.

Further, air forces can be classified by origin so that we have those which evolved from navies, those which evolved from armies and those which were formed from both services. The R.A.F. is the best example of the last classification. Although this is not intended as a history of specific air forces it is worthwhile recalling that the principal air service of the British Empire had to undergo some drastic surgical operations before it attained its present form. First it was a somewhat unhappy marriage of the Royal Naval Air Service and the Royal Flying Corps; then the maritime element was split so that aircraft-carrier squadrons had two masters, the Admiralty and the Air Ministry. Next, the Fleet Air Arm was amputated from the R.A.F. and the Admiralty got back the R.N.A.S. which it had lost to the R.A.F. in 1918. Finally, in the middle of the 1939-45 war the R.A.F. nearly lost complete control of its Coastal Command to the Royal Navy.

Throughout its life the R.A.F., both in peace and war, has had to pursue a tricky path between the Admiralty and the War Office. At times it lost parts to both, sometimes it played one off against the other, and sometimes it even usurped the spheres of activity of the senior Services.

As can be seen, there is more than one possible form of air force and also some interesting methods of development. The question which arises is: What type of air force or air forces should a nation have? One of the first answers must depend on the desirability of having an independent force, for that is the most expensive both in terms of a nation's productive capacity and scientific brain resources. An independent air force is, possibly, an essential prerequisite for air superiority. But such a sweeping statement must be qualified. Although essential for air-superiority an independent force is not necessarily essential for overall military superiority; once air superiority has been attained it can become an expensive hobby.

As indicated at the beginning of this study, the subject is not a new one; therefore it is necessary to justify its reintroduction before proceeding further.

Weapons of war, and particularly those used for defence against

SEA, LAND AND AIR . . .

assault from the air and offence over great distances, are rapidly changing both in design and in strategic and tactical use. Therefore, the original conception of an independent air force, or for that matter an air arm, may no longer apply. The first air Services were established because the aeroplane was not just an improved gun or vehicle, but a revolutionary weapon. The aeroplane needed peculiar maintenance techniques and the training of specialized personnel. The flying-machine men had to be left to their own devices, and could not be expected to rush back and forth with the cavalry.

Nowadays, the guided missile and similar forms of air weapon place the air force in a situation comparable with that obtaining on the introduction of the aeroplane into navies and armies.

An argument can be based on the general consideration that aircraft are no longer specialized weapons, as all arms of a nation's fighting forces now have equipment as complex as the aeroplane. Even so, the use of aircraft for all but close support of an army or navy is a specialized business, embracing the exercising of command over space and time.

All this leads back to the principal question which arises from such considerations: how should a nation's total military potential be divided? Should there be one military Service with three branches, or two Services each with an air arm, or three independent Services plus numerous private armies, navies and air forces?

After only a decade of military flying Britain adopted the three-Service system by the simple expedient of tearing out pieces of the Royal Navy and the Army and setting up the R.A.F. or, as Sir Philip Joubert de la Ferté termed it, the Third Service. But for the *esprit de corps* of the R.N.A.S. and the R.F.C., and the determined efforts of such airmen as Lord Trenchard, the R.A.F. might have survived for only a few years before it was dismembered by politicians and the well-meaning, but unfortunately misguided, attentions of its parents the Royal Navy and the Army. As it was, the Service struggled upwards against much opposition. Despite its internal problems it still found time to keep the peace in the Middle East by the then-acceptable practice of exercising "control without occupation." In 1939 the R.A.F. lost control of the Fleet Air Arm, and ever since then the air branch of the Navy has had to fight hard for the right equipment against opposition which was comparable with that experienced by the R.A.F. in its earlier days.

In Britain the three-Service concept eventually flourished, and in time of defence, such as 1940, it proved to be to the nation's advantage. But for the independent R.A.F. and its most "independent" Fighter Command, which husbanded the nation's principal defensive weapons, the eight-gun fighters, history after 1940 might have been very different.

In other phases of the war the independent air force was not always such a blessing to the other Services. The Fleet Air Arm was starved of the right type of aircraft and the Army did not always get close air support comparable with that used by the Axis Powers. Of course, towards the end of the war the three Services drew closer together and heaped each other's resources on the others. Such examples of co-operation encouraged the exponents of the one-Service concept. It is possible that the days of even two Services are numbered and that eventually there will be one supreme command organization which will extend down to Fleet, Army and Air Command level. The staff colleges now embrace all facets of military operations, so that during the past 25 years a generation of staff officers has been trained capable of fighting a war in all three mediums.

R.A.F.-R.N. Amalgamation?

Recently suggestions have been put forward at the highest levels of government that the Royal Navy should absorb the Royal Air Force. In practice such a blunt proposal would be disguised under such expressions as "amalgamation" or "detailed co-operation." Both Services are related and have much in common, particularly organization, and could, therefore, exercise the traditional function of the Navy—the command of the sea and the shore—more efficiently by including the command of the skies. Both Services have considerable experience of working together, even more so than co-operation between the Army and the R.A.F. The principal example of co-operation—and incidentally a possible precursor of such an amalgamation—was the operational control by the Navy of the squadrons of R.A.F. Coastal Command during the 1939-45 war. In addition, the F.A.A., whilst possibly not giving a good example of high-level co-operation, did infuse into the R.A.F. a strong sense of the needs of maritime warfare and an understanding of the sea—something more significant than the "nautical" practices of the R.A.F., such as the flying of its ensign from the gaff along with the station commander's pennant at the masthead, or the wearing of the naval-type sword affected by the officers.

With one Service there would be a considerable saving in the nation's military resources of both brains and materials.

As a corollary to such a proposal it might be suggested that a single triphibious service would be better still. This could possibly be answered by quoting two principal military functions: The seizure of space (land, sea or air), and the retention of space. The seizure of space more often than not requires the support of a navy and air force (or, as we are considering an amalgamation, a sea air force) whereas the retention of space—and, in particular, land, which is the only tangible medium as far as military government is concerned—requires a "foot-on-the-ground" army. The rôle of an army must remain, therefore, somewhat different from that of navies and air forces.

If the Admiralty had been able to secure for its own use the principal air force in 1918 then Britain might have been spared the inter-Service arguments that followed. Had such a thing happened, then it would have been hoped that the Navy would have used its air force not only for tactical purposes, both naval and army, but also for the exercising of the global concept of air power similar to that now practised by the U.S.A.F. As a matter of interest the R.N.A.S. was not unaware of its own potentialities. In 1918 it formed some Handley Page 0/400 heavy-bomber units which would have been the counterpart of today's strategic bomber squadrons.

Perhaps such an amalgamation of the Royal Navy and the R.A.F. will yet take place. British sailors have always been most adaptable—as adept at fighting ashore as afloat—and it is not difficult to see that if the R.A.F. were absorbed it would contribute its experience of fighting in all three media to the overall function of the new service. Such an amalgamation would not necessarily do away with one of the principal land/air activities, the operation of tactical close-support aircraft. However, it could not make the present situation any worse. The Army would still be in the same customer-supplier relationship as it was with the R.A.F.

Flexibility of Action

The essential requirement is not concerned with who commands such operations but whether or not the operational techniques and the communications facilities exist which allow aircraft to be rapidly switched from one type of operation to another. That, possibly, is one of the major factors which is sometimes overlooked by the protagonists of the one-Service concept. As long as full co-operation and planning exist which are based upon the maximum military utilization of aircraft, then the necessity for the wholesale swallowing of an air force into a single Service does not always arise. In the case of a navy and an air force there are other considerations to be taken into account which do not involve command relationships. As an example, both services use aircraft in large numbers, one because it needs them for most operations and the other because that is its primary function; and both have to exercise surveillance by patrols and by radar over areas which are divorced from geographical features. There is, therefore, justification for suggesting that Britain's navy and air force could be combined into a single Service which could police the world by areas and not by shore boundaries.

The other consideration which arises out of such thinking, particularly when a sea air force is considered, is the possibility of allowing the army its own air arm—that is, of course, if a nation can afford such dependent forces. With unlimited resources it is difficult to find objections to an army air arm. However, when a nation's military services must exist on an unrealistic budget then the presence of "private" squadrons cannot always be justified.

An army should possibly be allowed to establish an air arm containing aircraft which improve the performance of existing weapons—aircraft such as observation and spotting machines, and short-range transports. Present practice in Great Britain and the U.S.A. differs. The R.A.F. supplies spotting aircraft to artillery formations along with supply and maintenance facilities, including personnel, whilst the Army provides specialist officers who are artillery men first and pilots second. In contrast, the U.S. Army has its own air corps which is completely independent of the U.S.A.F.—that is, excepting navigational facilities. The Pentagon has set an upper limit to the weight of fixed-wing aircraft which the Army can own. There is no such limit for helicopters, so the U.S. Army can indulge in the luxury of having a method of short-range transport which can operate independently of fixed installations. Both the U.S.A.F. and the R.A.F. have long-range transport which can be made available to the other Services; unfortunately for the R.A.F., Britain can afford only a few transport aircraft for Service use, the majority going to civilian operators.

The U.S.A.F., whilst not quite ten years old in name, is an example of the establishment of an independent air force against opposition which was possibly even stronger than that encountered at times by the R.A.F. It is also an example of "hasten slowly," for if General Arnold had not curbed the impatience of his colleagues, both in tthe U.S.A.A.F. and the U.S. Government, the independent U.S.A.F. might have been launched both in name and practice at a most inopportune time—at about the time the U.S.A.A.F. was adapting itself to air war in both hemispheres simultaneously.

[*Continued on page 763*

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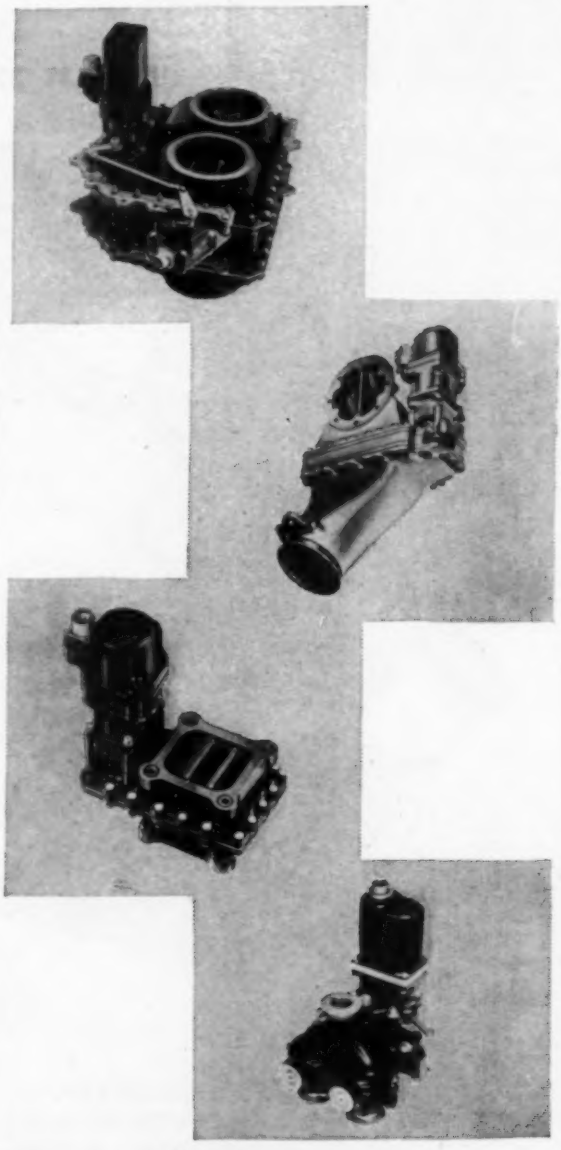

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SEA, LAND AND AIR . . .

Although the U.S.A.F. is backed by immense resources of money and production potential, its resultant size and global commitments have not been based upon the wasteful expenditure of the taxpayer's money. Each command, each unit and each commander is accountable to the U.S. legislature for every dollar that is spent.

To outsiders its surface activities might appear somewhat brash and unnecessary. However, behind the façade of good and energetic publicity—such as that indulged in at "box-office" level—there is a most purposeful efficiency. This efficiency in the use of available resources and manpower appears to be founded upon two precepts: first, the absence of any demarcation between active and cold-war conditions; and, secondly, as stated, the careful use of its money, which in 1955 totalled $15.5 billions.

The command which best exemplifies the whole of the U.S.A.F. activities is Strategic Air Command. Under the generalship of Curtis E. LeMay there are 55 wings of strategic bomber squadrons (a U.S.A.F. wing is comparable in size with two R.A.F. wings). The primary function of S.A.C. is to deliver a thermonuclear deterrent bomb to any part of the world at a moment's notice. To ensure that it is always ready for such operations it is keyed to wartime conditions, so that the highest possible proportion of its aircraft are serviceable and manned by fully trained crews. In addition, S.A.C. is always mindful of a possible "Pearl Harbour" blow; therefore, it guards its installations in a most thorough manner.

Although the U.S.A.F. is as independent as the R.A.F., it has yet to acquire full control of all ground-to-air missiles and anti-aircraft guns. This introduces another facet of inter-Service responsibility. In 1940 the R.A.F. exercised operational control over the anti-aircraft guns of the Royal Artillery, whereas its opponent the Luftwaffe controlled and administered its own Flak units. A similar situation existed in the wartime U.S. services. It is interesting to note that General Pile contemplated handing over the anti-aircraft service to the R.A.F. *in toto*. However (and as in the development of the U.S.A.F.) such a step was difficult to take in the middle of an all-out war. Nowadays such a situation may not arise, as guided missiles and rockets used for anti-aircraft purposes are more closely related to aircraft operating and guidance techniques than are guns. As far as can be ascertained, Britain's anti-aircraft defence responsibilities of Fighter Command will be entirely under the operation and administration of the R.A.F. As has been indicated, the situation in the U.S. is somewhat confused, as all three Services are hard at work developing guided missiles and rockets independently of each other. Such developments prompt the suggestion that as the future missiles are related only to air force operations—in so far as aircraft were related to motor vehicle and ship operations in 1914—a new Service might arise, which in Britain and the U.S. would be the fourth. Of course, it is reasonable to assume that the majority of missile development and operations will remain with air forces for some time, particularly as these forces have established the communication and information transmitting networks, such as radar, which can be adapted to control missiles.

What is most likely to occur in the majority of countries in the future is the gradual development of specialized Services, each based upon the exercising of one overall military function. As an example, the "Defence Service" would comprise sea, land and air components, all under one command, charged with the repulsion of attacks from all three media. The "Offence Service" would be also a triphibious one, consisting of specialized task-forces, both tactical and strategic. Communications, including "track" maintenance of seaways, roads, railways and airways along with transport in all media and personnel services, would together form a third Service. An additional Service would be needed if there were large areas of land to be retained after being conquered by the Offence Service; it would be similar to present-day armies employed as policemen in a subdued territory.

All four Services of the future will most likely be directed from one ministry.

In such a possible disposition of a nation's military strength aircraft will be used by all forces both as a vehicle and as a weapon; but as things are at present the independent air force, together with guided missiles, seems to be the best way of using air power—if, of course, it can be afforded.

CRANFIELD'S ANNIVERSARY DINNER

SPEAKING at the College of Aeronautics tenth anniversary dinner in London on October 26, Sir Roy Fedden disclosed details of the original conception of the College. It may be recalled that Sir Roy was chairman of the 1943 committee which prepared detailed plans for the establishment of "a school of aeronautical science" following the recommendation of the A.R.C. report instigated by Sir Stafford Cripps.

"I have heard different claims as to the authorship of putting the germ of the College into the brain of the late Sir Stafford Cripps," Sir Roy said. "I know that Sir Henry Tizard was very conscious of our limitations on technical staff after the war, and talked to him on the matter, but I believe the idea first took concrete form during a railway journey Sir Stafford made with Professor Blackett. Resulting from these talks . . . Sir Stafford wrote to Sir Melvill Jones . . . in the spring of 1943, with a request that the whole matter should be referred to the Aeronautical Research Council."

Sir Roy, who was proposing the toast to "The College and the Future," reviewed the first ten years of the College, and went on to compare the number of aeronautical engineering graduates in one recent year in Britain (60), the U.S.A. (1,000), and Russia (2,500). He then turned to consider the future. "A new breed of engineer," he said, "fundamental enough in basic science, and yet at the same time advanced enough in mathematics and humanities, is necessary to meet the tremendous demands of the future . . . I hope that at Cranfield we may lead a renaissance in British engineering to help meet the second industrial world revolution already upon us, in which there will be bitter competition such as we have never known before."

Replies were made by the chairman of the Board of Governors, Sir Frederick Handley Page; and by the Principal, Prof. A. J. Murphy, who disclosed that the 1956 student entry numbered 98—the highest total in the history of the College. An additional current activity was the one-year course on guided weapons organized for students of the NATO countries.

The chairman at the dinner, which was held at the Connaught Rooms, London, was Mr. Harold Caplan, a member of the first (1946) student entry and present chairman of the Cranfield Society. Graduate representatives from each year since the College's formation were among the 150 people present; unfortunately unable to attend were Mr. E. F. Relf, the first Principal, and Sir Edgar Ludlow-Hewitt, the first chairman of the Board.

Seen at the College of Aeronautics London dinner: (upper left) Sir Roy Fedden, Sir Frederick Handley Page, Prof. A. J. Murphy and Sir Matthew Slattery; (upper right) organizers of the dinner — Mr. Harold Caplan, Mrs. F. Dixon, Mr. Cyril Cleverdon and Mr. T. L. Palmer; (lower left) ex-presidents of the Students' Society — Lt-Cdr. D. G. Titford, Mr. R. C. Davison, Mr. T. M. Corson, Cdr. A. J. Monk and S/L. L. Ellerd-Styles; (lower right) Sir Victor Goddard and Sir Harold Roxbee Cox.

"Flight" photographs

Correspondence

The Editor of "Flight" is not necessarily in agreement with the views expressed by correspondents in these columns; the names and addresses of the writers, not for publication in detail, must in all cases accompany letters.

Another U-2 Identified

WE wish to claim seeing an aircraft which we believe to be the Lockheed U-2. It had a high-mounted wing and tailplane; the straight wing, of fairly high aspect-ratio, was mounted well back along the fuselage. The intake appeared to be in the nose, and the whole aircraft was finished in silver. It appeared to be completely void of markings. It disappeared at a fairly high rate of climb.

It was seen in the Farnham area on Friday, October 26, and on the following Monday. Can any other reader verify this claim?

Elstead and Haslemere. A. GATES
D. FARRANT.

The 1½-Strutter

AS an original member of "B" Flight, 70 Sqn., I feel I should say how much I enjoyed the two first-class articles on the Sopwith 1½-Strutter by J. M. Bruce. They certainly brought back memories, especially the paragraph on page 587, recalling the occasion on which, out of the evening sun, we bounced the ten Hun two-seaters just S.E. of Bapaume.

I enclose a blow-up of a snap I took from the back seat as we crossed the lines over Delville Wood just before the set up. Capt. Sanday and 2nd Lt. C. W. Busk were in the centre aircraft; I believe Lt. Gilray and 2nd Lt. Purser were to port, and Lt. C. W. Blair and myself were to starboard. Lt. Gilray's aircraft was the first new one in "B" Flight and the first one painted brown.

The numbers of the first six aircraft of "B" Flight were A380 to A385. A380 to A384 only lasted until mid-August, but A385 (which was Lt. Vernon-Browne's) lasted until spring 1917, when the C.O., Major Tedder, wrote it off on landing after an air test. All the original aircraft of "A" and "B" Flights had Nieuport mountings.

Farnham, Surrey. USQUAM.

Helicopter De-icing

I READ in a Polish periodical, about two months ago, that Poland has commenced to manufacture helicopters. The article concerned lists some brief specifications, and claims that the helicopter's rotor blades are fitted with de-icing installation—"which so far has not yet been incorporated by the manufacturers in the West."

Although I am not an expert in the fields of aeronautics I thought the claim to be somewhat out of perspective in view of all the helicopters which operate during winters and near the Poles.

No one doubts the fact that the Polish helicopter SM-1 has rotor de-icing equipment, but surely the Western helicopters must have been using some kind of de-icing system for a number of years in order to keep their products flying in below-zero temperatures?

Luton, Beds. ZB. PODSTOLSKI.

[Much experimental work has been done (a note on tests with a Bristol Sycamore appears on page 752), but so far as we are aware no Western helicopter manufacturer is yet offering a standard installation. De-icing paste is normally used.—Ed.]

Britain's Airline Equipment

IF I may be allowed to comment on a recent letter by "Icarus" (*Flight*, October 19) it is that while he initially discusses the efficiency of airliners in relation to their size he quickly returns to the old subject of airline equipment, with, of course, the contention that B.O.A.C. should be allowed to buy equipment from whom they wish.

No one would dispute the sorry history of British-designed long-range aircraft to date, but when "Icarus" uses the term "proven" he apparently overlooks the fact that neither the Constellation nor the DC-6 were, originally, proven in the sense we would use the term today. Initially, these aircraft were, if anything, less promising than the Britannia is today, while the number of fatal accidents with either aircraft, due to design faults, exceeds that of the Comet by far. That these aircraft are now excellent machines is due chiefly to their use in large numbers, either by the American fighting Services, or by airlines who were prepared to continue using them.

I do not think that "Icarus" appreciates what he is advocating. If B.O.A.C. were given a completely free hand, one suspects that they would buy exclusively American. In that event, no British manufacturer would ever be given the opportunity to develop an efficient long-range commercial airliner and the loss of trade and prestige to this country would be considerable. The Tudor and the Hermes failed, almost certainly, because they were the products of inexperience. Furthermore, they were no improvement whatever on existing equipment. Inexperience, and too great haste, were almost certainly the cause of the Comet disasters.

It is generally agreed that the Britannia has great development potential, both in speed and work capacity. The prophets, who predict its demise, on the grounds that it is too late a-coming, may yet be proved false.

And finally, may I point out that by 1960 the Far-East route will be, possibly, the most interesting of any to commercial airlines? On this route the Britannia, Comet and Boeing 707 (with British and American engines) will be flying in direct competition with one another. Passengers will have a free choice of any of these three aircraft and it will be instructive to see which they prefer. I would hazard the opinion that unless the American jets can consistently operate at an economic load factor they might conceivably prove to be one of the costliest mistakes in aviation history. After all, it is the passenger who decides the ultimate success or failure of an aircraft, not merely the efficiency of the aircraft itself, or its ability to earn money *when* carrying passengers. And it appears to be overlooked that the size of the DC-8 and the Boeing 707 was determined, in the first instance, not by any ideal or optimum work capacity but by the need to make non-stop flights across the North Atlantic. Their great work-capacity will only earn money for their operators provided there is sufficient traffic to harness it.

Twickenham, Middx. A. S. RICHARDSON.

Sopwith 1½-Strutters going into action—the snapshot referred to in the letter from "Usquam." Air-to-air photographs from the First World War are comparatively rare, probably owing to the unwieldiness of cameras at that time.

FORTHCOMING EVENTS

Nov.	9.	Blackpool and Fylde Aeronautical Society and Blackpool and Fylde Aero Club: Dinner Dance.
Nov.	9-10.	Agricultural Aviation Show, Palmerston North, New Zealand.
Nov.	10.	Society of Licensed Aircraft Engineers: All-day Meeting: "Non Destructive Testing and Inspection."
Nov.	13.	Institute of Transport: Anniversary Luncheon.
Nov.	13.	R.Ae.S.: Section Lecture: "Air Conditioning of Aircraft," by Dr. E. W. Still, F.R.Ae.S.
Nov.	14.	Kronfeld Club: "Navigation Across the Tasman Sea in 1930," by Francis Chichester.
Nov.	14.	Radar Association: "Infra-Red: Its Problems and Possibilities," by Dr. F. E. Jones, M.B.E., B.Sc., Ph.D., A.M.I.E.E.
Nov.	16.	Institute of Navigation: "Navigational Aspects of Turbo-prop Operations over the North Atlantic," by J. E. D. Williams.
Nov.	20.	R.Ae.S.: Section Lecture: "C. of A. Flight Testing," by D. P. Davies.

R.Ae.S. Branch Fixtures (to November 21):

Nov. 12, *Glasgow*, "Uses of Electronic Computing Machines," by R. J. A. Paul; *Halton*, Film Show; *Henlow*, "Use of Plastics in the Aircraft Industry," by H. V. Potter. Nov. 14, *Leicester*, "Manned Flight into Outer Space," by T. Nonweiler. Nov. 16, *Birmingham*, "Silencing of Jet Engines," by F. B. Greatrex; *Luton*, Branch Dinner. Nov. 19, *Halton*, Film Show. Nov. 21, *Bristol*, Junior Members' Papers Competition; *Christchurch*, "Aeroplane Noise: A Challenge," by Prof. E. J. Richards; *Coventry*, "Some Influences of Equipment and Systems on Aircraft Design," by C. F. Joy; *Reading*, "Interplanetary Flight," by J. Humphries; *Weybridge*, "New Machining Techniques in the Aircraft Industry," by L. G. Burnard and T. A. Waite.

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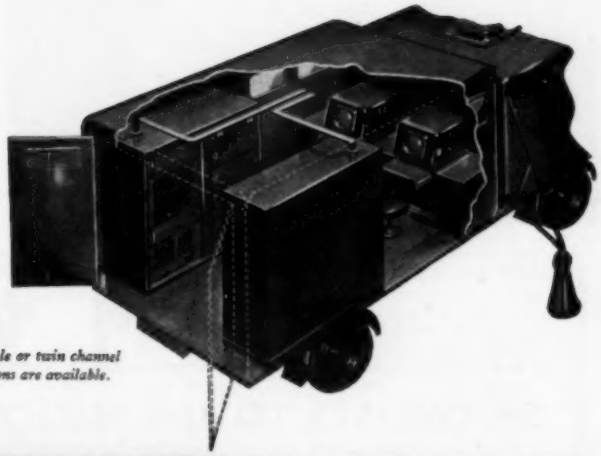

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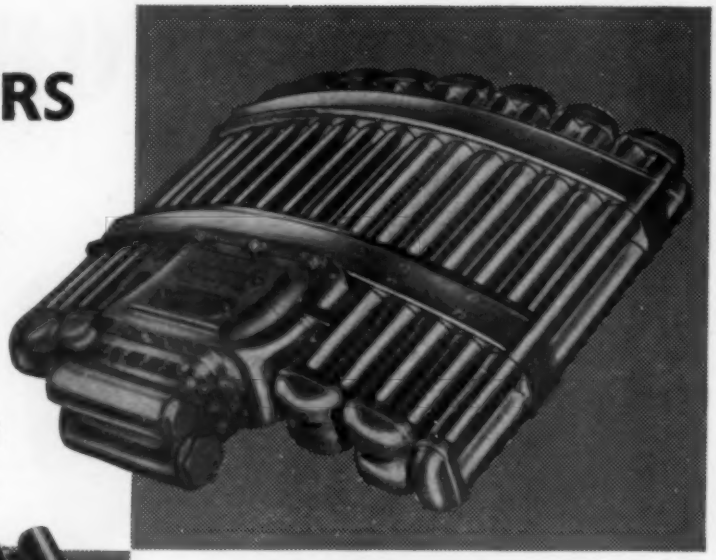

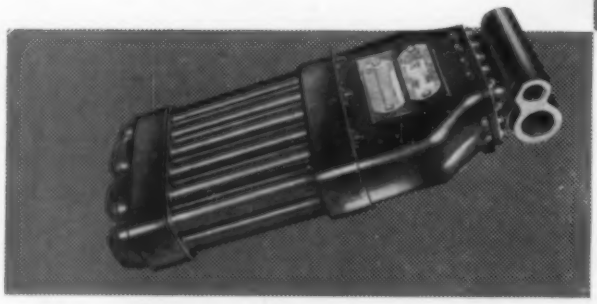

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THE INDUSTRY

All-weather Hangar

HOUSING aircraft securely in severe climatic conditions where high winds or snow may be experienced, and yet so they can be got out in a matter of seconds, involves some complex problems in hangar design. These have been carefully studied in the design of a new type built by the Coseley Engineering Co., Ltd., Wolverhampton, Staffs.

This is a steel-framed hangar, clad with unpainted Noral "Industrial" corrugated aluminium sheets, curved at the eaves both for appearance and also to slide snow off, and strong enough to take a snow load of 60 lb sq/ft. Each of the two bays of each hangar is 100ft long, 83ft wide and 34ft 6in high.

One of the most interesting features of these hangars is the construction of their doors, which are in three 25ft sections, situated across the 83ft ends. These doors are of the roller-shutter type, able to withstand a wind loading of 20 lb/sq ft and yet capable of being fully opened in 30 seconds.

They are constructed of aluminium panels operating with counterweights on the release of a locking device, and can be moved either by hand or electrically. Aluminium used in the doors is Noral B51SWP alloy (to B.S.S. 1476 HE30WP) for the frame sections, with "Industrial" aluminium trough section faced with flat sheet of Noral 3SH alloy (to B.S. 1470 NS3).

The design of the doors was carried out by the Coseley Engineering Co., Ltd., in conjunction with the Northern Aluminium Co., Ltd., the suppliers of the material used.

One of the new Coseley hangars described above.

Lightweight protective suits made by the R.F.D. Co., Ltd., Godalming, Surrey, are used by personnel working at the de Havilland rocket-motor test beds at Hatfield. Designed to give protection against high-test peroxide, this new type of suit, weighing only 3 lb (approx.), is made of Terylene coated with Geon polyvinyl chloride.

New Aircraft Cable

FROM Rists Wires and Cables, Ltd., Lower Milehouse Lane, Newcastle, Staffs, comes information that they are now producing the new "Nyvinsmall" aircraft cable covered by Ministry of Supply specification EL 1910.

This cable has been developed for use in the wiring of non-essential circuits in aircraft, where the potential between conductors or between conductor and the aircraft structure does not exceed 250 volts (r.m.s.), and where the frequency does not exceed 2,400 c.p.s.

The cable is composed of stranded tinned copper or cadmium copper, p.v.c. insulation and nylon sheathed. It is resistant to oils and is suitable for low temperature duty where the combination of the ambient temperature and the current for continuous service does not produce a stabilized conduct or temperature higher than 70 deg C, though the cable is not flexible at those temperatures.

Permali Centralization

OVER 200 guests were present at the recent laying of the foundation stone for the new Permali factory at Gloucester by the Bishop of Gloucester, the Right Rev. W. M. Askwith. This factory, due to be completed by September next year, will permit centralization of the manufacturing processes of various units within the Permali, Ltd., group, which includes Hordern-Richmond, Ltd., Hydulignum-Jabroc (Tools), Ltd., and Jabroc, Ltd., and manufactures a wide range of densified-wood laminates under the trade names "Permali," "Permawood," "Hydulignum" and "Jabroc," together with "Dialam" Bakelized paper bushings and "Permaglass" glass-fibre laminates.

IN BRIEF

Mr. T. G. Hicks, managing director of Power Jets (Research and Development), Ltd., is making a short tour of Canada and the U.S.A.; his business will include the discussion of licences under Power Jets patents in both aeronautical and industrial fields.

* * *

One of the latest David Brown 30 IDT aircraft-towing tractors has been loaned to the Royal Norwegian Air Force by the David Brown Industrial Tractor Division for three months' extended trials in Norway.

* * *

We regret to record the death of Mr. Denis Harvey Murphy, a senior member of the firm of Connolly Bros. (Curriers), Ltd. Mr. Murphy, who had been with the company 52 years and played a large part in building up its business, died at his Northwood home on October 21.

* * *

Mr. Robert Appleby has been appointed managing director of Black and Decker, Ltd., Harmondsworth, Middlesex. He succeeds the late Mr. J. V. Franklin, who died on October 7. Mr. Appleby will retain his position as director of international operations of the parent company, the Black and Decker Mfg. Co., Towson, Maryland, U.S.A.

* * *

An aircraft division has been formed by Bell's Asbestos and Engineering (Holdings), Ltd., Bestobell Works, Slough, Bucks. It will have headquarters at Slough and be under the management of Mr. J. E. Heald. For many years past the firm has supplied various asbestos and asbestos-based materials and components for the aircraft industry.

Two new films, *Hydraulic Systems* and *Diesel Engine Lubrication*, have been added to the industrial film library established in 1953 for the benefit of the Mobil Oil Co., Ltd., and its affiliates. The first-named shows how fluid power transmission is used in the air, on land and at sea, illustrating and explaining the different types of pumps and valves required, and describing the special properties of hydraulic oils. The other film illustrates the operation of every type of diesel engine, from the simple four-stroke to the complex opposed-piston two-stroke.

W/C. A. E. Dale, A.F.C., D.F.M., R.A.F.(rtd.), who has been appointed an executive of the Pulsometer Engineering Co., Ltd., to carry out liaison duties in connection with their aircraft fuel-pump products. W/C. Dale (here seen in the acting rank of group captain) was apprenticed at Halton, served in Nos. 6, 9 and 14 Squadrons, became chief instructor at No. 3 F.T.S., then C.F.I. at the Central Flying School and later Chief of Staff, Royal Ceylon Air Force.

CLUB AND GLIDING NEWS

At Stapleford Tawney Aerodrome, Tipsy Trainer G-AFWT is operated by the Percival Flying Group (see below). In this photograph are David Smith (in cockpit) and F. I. V. Walker.

THE Percival Flying Group, visited recently by *Flight*, is an example of what can be done by a small firm or a small group of enthusiasts with limited financial resources. Operating from the firm's premises at Stapleford Tawney, a few employees of Edgar Percival Aircraft, Ltd.—representing a much larger potential membership—are gaining experience on the club's Tipsy. A Tipsy because a process of elimination rendered the chance of purchase of one with a three-year C. of A. last April an ideal opportunity to obtain a suitable side-by-side two-seater. "E.P.'s" pioneering of the monoplane light aircraft in the thirties rendered a biplane out of question and—well, it could hardly have been an Auster, could it?

Since putting the aircraft into service, the first six members of the group have started to accumulate flying time steadily, although the lack of an instructor on the strength and the limited previous experience of most of the pilots have proved a handicap. The friendly Herts and Essex Aero Club have, however, lent a helping hand and the use of their fine club-house on the aerodrome (of which they are the owners).

As always with a one-aircraft club, the Tipsy is regarded with considerable technical interest and affection by all the members. The installation of a new Walter Mikron engine will be undertaken by the parent firm very shortly; all the maintenance is supervised by Edgar Percival's licensed engineer. "E.P." is to be admired for providing money and encouragement in helping enthusiasts in his firm to fly and to obtain their licences. It is hard to believe that this is pure altruism; rather, we would hazard, it is the considered judgment of an employer who believes that there are real benefits to be obtained from a personal interest in flying among the members of his staff.

A JOINT dinner-dance is being held by the Blackpool and Fylde Aeronautical Society and the Blackpool and Fylde Aero Club tonight, November 9. All interested in aviation are invited to join the Society; inquiries should be addressed to Mr. L. Ash Lyons, Squires Gate Airport, St. Anne's-on-Sea.

A SECOND aircraft, a Wicko G.M.1, has been acquired by the Southport Aero Club, to supplement the Tiger Moth already operating. The Wicko was flown up to the club's beach airstrip from White Waltham last month by Mr. H. Harker, chairman of the club.

WINTER lectures at the Elstree Flying Club began on Wednesday last, November 7, which was also the date on which night flying at Elstree was due to be resumed. A car rally has been organized for November 25.

FIRST annual general meeting of the Kronfeld Club was held on Friday, October 26, in the club's lecture room at 74 Eccleston Square, London, S.W.1. Some 70 members heard the secretary, Hugo Trotter, report on the progress and growth of the organization. It will be remembered that the club was formed to provide a social centre in London for members of the Popular Flying Association and gliding enthusiasts. There are now over 250 members and the club is frequently visited by foreign pilots.

Mr. Trotter reported that the Wednesday lectures and film shows were proving very popular, and the course of Thursday-evening lectures by Dr. Scorer and Mr. Irving on *Flight and the Atmosphere* was very well attended. He added that, although the bar continued to show a profit, the club urgently required various items of equipment, such as a film-and-slide projector. For this reason, the meeting was reluctantly asked to approve an increase in the annual subscription from 10s to 15s. This was approved.

NEXT year's National Gliding Championships, it is understood, are to be held at the Lasham Gliding Centre from July 27 to August 5. Lasham's offer to hold the contests there has been accepted by the British Gliding Association, but final approval from the Air Ministry, who own the site, has not yet been received.

KENT Gliding Club's Christmas party is to be held on December 22 at the club-house, Detling. Good progress since the club was re-formed earlier this year is reported in the current newsletter.

MARCH 15, 1957, is the date planned for the next annual Gliding Ball organized by the B.G.A. As in previous years, it will be held at Londonderry House.

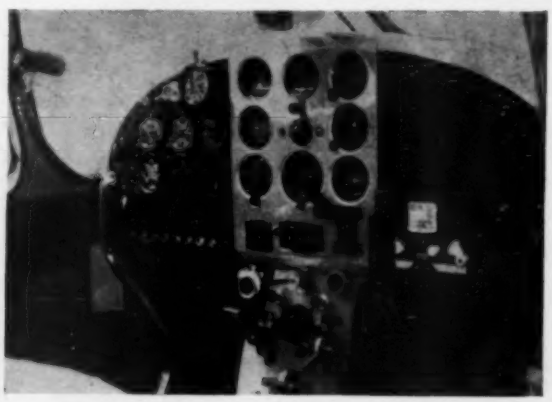
A NEW type of sailplane recently arrived at Lasham is the Schweizer 1-26 owned by Capt. Ray Young of Pan American Airways. The Schweizer was delivered in kit form to Capt. Young at London Airport in April last, and its assembly was completed last month. The date of Lasham's Christmas party this year is December 15, when "friends are again cordially invited if they are strong enough to stand the pace." Other news of significance to all who inhabit or visit Lasham is that a new addition of general convenience has been officially opened.

NOW being test-flown in Italy is the Pasotti Sparviero F.9, a low-wing, four-seater touring aircraft with nosewheel undercarriage and wooden structure. It is derived directly from the twin-engined Pasotti F.6 Airone, and its trim lines are characteristic of the work of designer Stelio Frati. The prototype is powered by a German eight-cylinder, 240 h.p. Hirth engine, without supercharger, but production aircraft will have a 260 h.p. Lycoming. The airscrew is an electrically controlled constant-speed unit. Undercarriage and flap are actuated by Magnaghi hydraulic units of the type which have given excellent service in the Italian Air Force for many years.

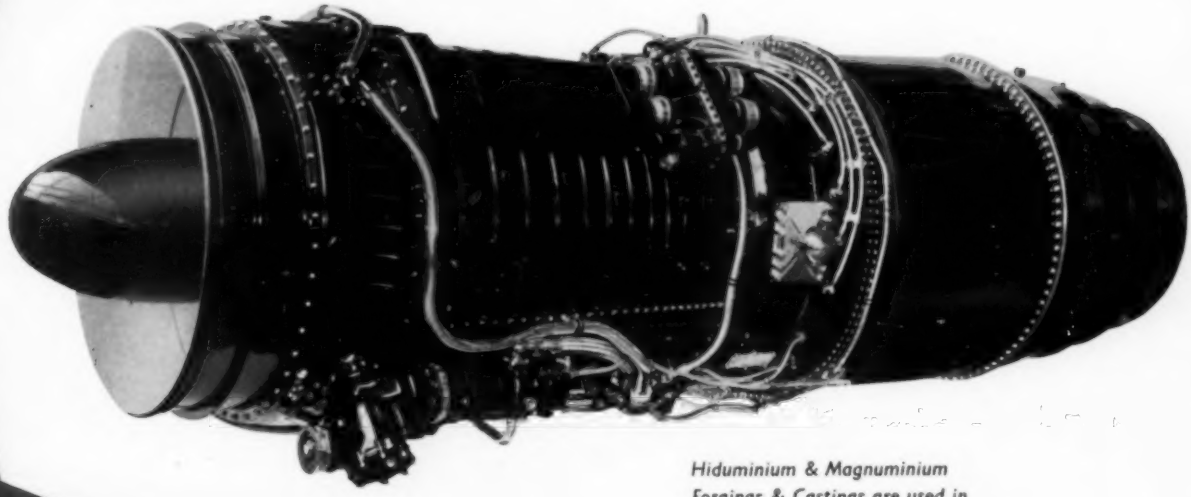
Provisional performance figures for the prototype Sparviero, with the 240 h.p. Hirth engine, are: top speed, 202 m.p.h.; ceiling, 18,000ft; effective range, 810 miles. Equipment includes a blind-flying panel, night-flying lighting, Narco V.H.F. radio, I.L.S. and radio compass. Oxygen can be carried and the seats have provision for parachutes. As the c.g. of the aircraft is well forward, a large luggage compartment, accessible from outside, has been arranged behind the cabin.

Leading data of the Sparviero are as follows: span, 32.8ft; length, 27.2ft; wing area, 158.2 sq ft; aspect ratio, 6.8:1, empty weight, 2,094 lb; useful load, 1,213 lb; total weight, 3,307 lb; wing loading, 20.9 lb/sq ft; power loading, 13.8 lb/hr.

The Pasotti Sparviero F.9, described in col. 2, is now being flight-tested. The prototype is powered by a 240 h.p. Hirth engine.



In every British Aero Engine



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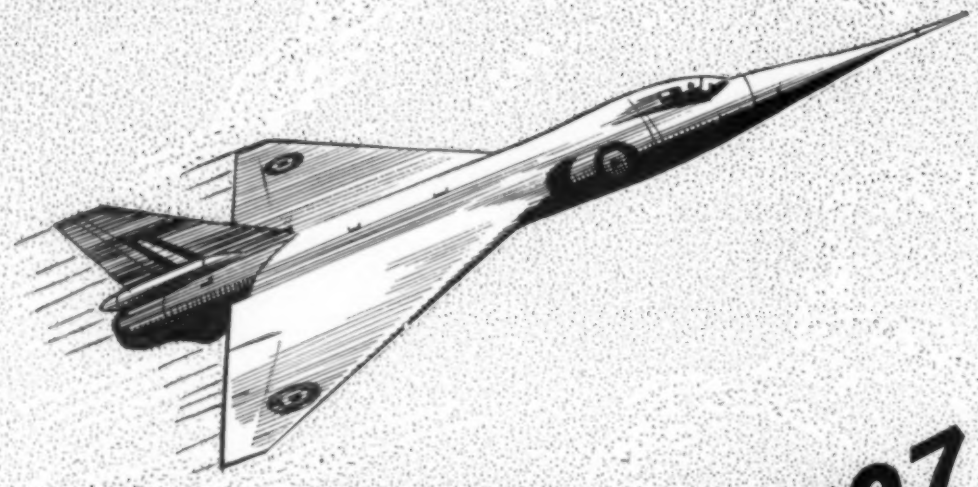

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Delivered two days ahead of schedule, B.O.A.C.'s first Douglas DC-7C is seen arriving at London Airport. Captain M. R. Alderson, the 7Cs fleet manager, accompanied the crew from San Francisco. (Details of the flight, p. 770.)

"Flight" photograph

CIVIL AVIATION

POINTS FROM THE CIVIL AVIATION DEBATE

BECAUSE of the Middle East crisis little prominence has been given to the important civil aviation debate which took place in the Commons last week. Indeed, so disorderly was the House last Friday morning that it seemed to *Flight's* representative as if the debate would not take place. However, Mr. Harold Watkinson, Minister of Transport and Civil Aviation, succeeded on his fourth attempt (at 11.49 a.m.) in moving the debate.

Summarized here are the main points raised by various Members. For easy reference, continuity is broken in order to group these main points under selected headings.

Britannia. "We have two aircraft in Africa," said MR. WATKINSON, "carrying out many different modifications to try and speed up the solution to the [icing] problem . . . I think there is no expert in this field at the moment in this country who is not playing some part in trying to get this problem solved." Although he thought it unwise to be optimistic, two modifications—relatively simple—appeared to be promising.

MR. BESWICK (Lab., Uxbridge), for the Opposition, noted that £11½m had been spent on the Proteus engine—and that this was about the same amount as was spent on the Bristol Brabazon. "On Monday the Minister of Supply told us that the delay over the Britannia had not caused the purchase of American aircraft. He was wrong again; he does not know everything. The DC-7Cs were bought as an insurance against trouble with the Britannia."

MR. IAN MIKARDO (Lab., Reading) said that B.O.A.C. expected to lose £1½m through Britannia delays.

MR. JOHN PROFUMO, Joint Parliamentary Secretary to the M.T.C.A., said that the Britannia's Certificate of Airworthiness had not been affected. Arrangements had been made so that the aircraft should not fly higher than 16,000ft in the particular icing conditions concerned.

B.O.A.C.'s Boeing 707 Order. "They [Boeing] have built up an enormous volume of flying experience," said MR. WATKINSON, "and have put this aircraft forward in time two or three years more than anyone expected twelve months ago." [In October 1955 Boeing contracted to deliver 20 707s, starting in 1958.] B.O.A.C. had found, he continued, that the 707 and DC-8 were not suitable for "many other routes" than the North Atlantic—although even there the position was changing, because the promised Conway engine developed about 17,000 lb. [This is the first official disclosure of the Conway's thrust.]

MR. BESWICK said: "Those who warned that the cancellation of the V.1000 must mean the purchase of American jets have been proved correct . . . a complete reversal of Government policy which has taken place within ten months . . . I am emphasizing the differences between what he [the Minister of Supply] has now told us and what was said ten months ago, because I think we have to decide for ourselves what reliance and value we can place upon future decisions of the same right hon. gentleman."

D.H.118. MR. WATKINSON said: "The enquiries which were made seemed clearly to show that, because all other major airlines had formally committed themselves to either Boeing or Douglas aircraft, there would be no export possibilities for that type of aircraft." The B.O.A.C. committee, he continued, decided that what was wanted—and the Corporation was in a position to place a "substantial order" for it—was an aircraft which would be a little faster than the Boeings [normal cruising speed 575 m.p.h.], and which would have as much range as the 707. In other words, it could do the Atlantic non-stop "in either direction," but would give a better performance, and have a better take-off and more flexibility of operation, while carrying perhaps 120 passengers as against the 150-170 of the Boeing. The Minister continued: "As I announced a week ago . . . the Government have told the Corporation, in agreeing to their purchase of fifteen 707s as a stop-gap operation, that it cannot be repeated." The D.H.118 would, he said, not only be sufficiently flexible to suit the Corporation's routes, but would have "great possibilities in the markets of the world."

"In the light of what the Government have said and done," said MR. BESWICK, "I cannot believe that B.O.A.C. now wants to buy another aircraft of this [Boeing 707] kind." MR. WATKINSON replied: "The fact is that this aircraft committee . . . had no directions from me, no pressure from me, and no instructions from me; it has come up with these two different requirements entirely as a result of its researches." MR. BESWICK thought that Mr. Watkinson was "being run" by the Minister of Supply. "Ten months ago this champion of the industry . . . told us that the British industry could not produce a long-range jet aircraft suitable for B.O.A.C. that could be sold abroad unless it was significantly better than American machines. . . . The possibilities have not been profoundly changed in the last ten months. . . . The same people are in the industry. The same possibilities as regards engines remain as they were ten months ago. There has been no significant new 'gimmick' thought up by the industry. . . . I am sorry, but I just cannot persuade myself that the right hon. gentleman is absolutely right in what he says. I do not believe that B.O.A.C. now voluntarily wishes to buy this particular machine." Unless the Minister of Supply told him otherwise, Mr. Beswick added, he was under the impression that the D.H.118 would be financed out of public funds.

MR. WATKINSON said that the D.H.118 had nothing at all in common with the V.1000. He repeated "nothing." It had got to perform quite a different function. "That is why I think it will sell; if it were the same it would not sell." To this MR. BESWICK replied: "I simply say that there are no possibilities of making this aircraft any better than the possibilities open to another company eighteen months ago. . . . Within those eighteen months almost every major operator in the world has committed himself to the DC-8 or the 707. . . . This aircraft . . . has far less chance of getting a sale in the markets of the world because all the other operators have in the meantime made their commitments ahead."

A. CDRE. HARVEY (Con., Macclesfield) pointed out that about four years ago Sir Miles Thomas said in B.O.A.C.'s annual report that he was examining civil versions of the V-bombers. "That examination never really took place. . . . About three weeks ago we were asked by telephone by one of the most senior executives of the Corporation whether we would be interested in a project called the 'Eastern' aeroplane. We said that we certainly were, because we had tried to get the Corporation interested in a civil Victor on which a tremendous amount of public money had been spent . . . our chief designer and his team sat up throughout almost every night for a week. They made a route analysis and prepared something which made a profound impression on the Corporation. We were then told last week, at about the time the Corporation's statement came out, 'Thank you very much for what you are doing, but the business is not coming your way.' Yet we had an appointment the next morning with the Corporation's technical staff to continue discussions."

MR. WATKINSON said that one of the considerations was that this aircraft must not only be capable of flying the eastern routes, but of operating the North Atlantic also. A. CDRE. HARVEY rejoined: "When we undertook this matter the Atlantic was not mentioned. This was to be an aeroplane capable of flying to Nairobi non-stop. [4,200 st. miles approx. from London.] That was the basis given to us. Something has slipped up somewhere."

[*Other matters in the debate we hope to summarize next week.*]

A Heron of the Queen's Flight was used by Princess Margaret during her recent tour of British Africa. Here Her Royal Highness is seen alighting from the aircraft at Sao Hill, Tanganyika.

CIVIL AVIATION . . .

NAVIGATION CONFERENCE ENDS

AT the end of the International Civil Aviation Organization's third air navigation conference in Montreal most of the objectives ("to give guidance to member nations to ensure the safe introduction of the jet era") had been achieved. In particular, I.C.A.O.'s international standards and recommended practices for airworthiness (which apply only to transport aircraft weighing more than 12,500 lb) have been completely revised to become very much broader and objective; and "acceptable means of compliance"—to use the jargon of I.C.A.O.—have been framed to help states keep their airworthiness code abreast of developments in aircraft design. The anticipated international requirement for rearward facing seats however, did not materialize; some of the delegates were of the opinion that passengers would be better protected by strengthening seat attachments and by removing obstacles in the cabin rather than by turning seats towards the rear.

Navigation lights were a further subject of discussion upon which recommendations were not finalized, but the conference was of the opinion that a special panel should be called to discuss the problem in greater detail.

Route qualifications for pilots (a controversial subject aired in *Flight* of May 18, 1956) have been revised so that the responsibility of determining such qualifications rests with the operator. The conference recommended that on any route or airfield where special difficulties existed the pilot should be given in-flight familiarization before he took command.

The relative responsibilities of the state and the operator in the field of operational control was set out in *Flight* of September 28. The conference defined its functions and purpose, and the associated communications, meteorological and air traffic services were listed. It was agreed by the conference that no state had any obligation to provide facilities required by an aircraft operator exclusively for operational control.

These important recommended practices and means of compliance must now be considered by the I.C.A.O. air navigation commission and approved by the I.C.A.O. Council.

Latest—and probably the last—development of the 049 Constellation of 1943, the Lockheed L.1649A, is seen here on one of its first test flights from Burbank, California.

OPERATIONAL CONFERENCE BEGINS

WHILE the third air navigation conference was drawing to a close another I.C.A.O. conference consisting of a panel of 19 experts nominated by 13 nations, I.A.T.A. and I.F.A.L.P.A. met in Montreal to "predict the special operational requirements for ground services and navigation aids of jet passenger aircraft that must be met if they are to be successfully incorporated into the international traffic pattern."

Work-lists were drawn up for: (1) air traffic services, (2) aerodromes, (3) meteorology and (4) communications. Various specialists (Mr. G. B. Trivett of the U.S.A.; Mr. R. Broadbent of the U.K.; Mr. J. Boom of the Netherlands; and Mr. R. H. Bulin of France) were appointed to study the respective requirements. Another meeting of the panel has been tentatively scheduled for January 1957 when the four specially selected members are expected to present working papers for study. It is hoped that the panel's task will be complete by next spring so that a report can be submitted to the I.C.A.O. air navigation commission.

AIRLINE SPECIALS

IN order to carry out investigations connected with the International Geophysical Year 1957-58, an international group of scientists has been invited by S.A.S. to take part in a special Copenhagen-Tokyo flight *via* the North Pole next February. The aircraft carrying the scientists and their instruments is scheduled to leave Copenhagen early in February, and will make intermediate stops at Fairbanks and at Anchorage in Alaska. This special flight will precede the official opening of the S.A.S. transpolar route between Scandinavia and Japan later in February, when two aircraft, one starting from Copenhagen and one from Tokyo, will pass one another over the North Pole.

S.A.S. is expected to make six further special flights when it carries the leaders and members of the Scandinavian Olympic teams—450 people—to the Games which open in Melbourne on November 22. Five DC-7s and one DC-6B will fly to the Antipodes *via* Lulea (north Sweden), the North Pole, Anchorage and Hawaii. The total travelling time will be about four days and will include a stop-over in Hawaii to acclimatize the passengers.

COST OF THE BRITANNIA

ABOUT £6,500,000 has been spent on developing the Britannia and £11,500,000 on the Proteus, according to a statement by Mr. Maudling, the Minister of Supply, in the House of Commons on October 29. He said that recoveries on this expenditure were made by levies imposed on the sales of production aircraft, engines and spares to customers other than Her Majesty's Government.

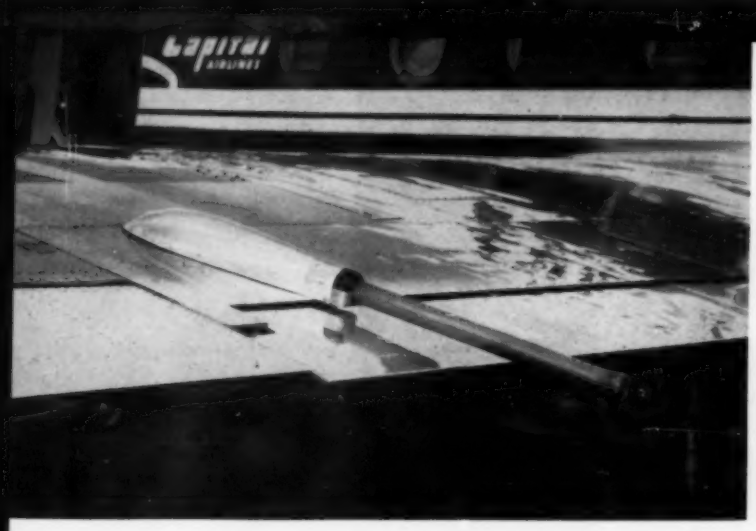
Questioned by Mr. James Callaghan, who wanted an inquiry to be held to determine "why there is no long-range British aircraft in sight, 12 years after the war, that B.O.A.C. can buy," the Minister said that it was "really wide of the mark" to talk about inquiry into an industry which is exporting £100m in a year. "There is no doubt at all," replied Mr. Maudling to further pressing by Mr. Callaghan on the subject of long-range aircraft, "that the long-range Britannia will be operating across the Atlantic before the Americans' long-range jet." We summarize the later Commons debate on civil aviation on page 767.

FEWER U.S. AIR ACCIDENTS

A REDUCTION in the number of aircraft accidents in the U.S.A. took place during 1955, with a particular improvement in instructional flying. Details are given in the 1955 edition of *General Aviation Accidents: a Statistical Analysis*, recently published by the Civil Aeronautics Administration. The total number of crashes dropped from 3,035 in 1954 to 2,948 in 1955; fatal accidents from 341 to 318, and fatalities from 610 to 544.

The decline in the number of accidents applied to most classes of flying, although there was a slight increase in the number of fatal accidents in non-commercial operations (which includes business flying). Instructional flying showed a marked decrease in fatal crashes from 64 to 34, while the total number of accidents fell from 648 to 610.

According to the C.A.A., the improvement in the instructional



Left, not a Viscount weapons system, but the new fuel jettison pipe (one per side) which is now a C.A.A. requirement on Capital's Viscounts. Right, provision for nose radar is now made on all new Viscounts for the company. It confers a pleasing new look to the nose.

safety record followed an intensive safety campaign by C.A.A. "general aviation safety agents." Special records were kept of every accident involving a student pilot, and each incident was followed up to determine the competency, not only of the student, but also of his instructor. "In some instances," the Administration reports, "the instructor required additional training to restore him to a suitable level of competency. In a few instances instructors voluntarily surrendered their flight instructor ratings, or did so after proceedings were initiated by the C.A.A."

TWO VISCOUNTS A WEEK—

LAST March we recorded the coincidence of the 300th Viscount order and the 100th delivery. Today, eight months later, each score has been increased by more than 50. The Viscount is thus being ordered at the rate of one aircraft every four or five days (present total 356), and is being delivered at the same tempo —a nice balance between supply and demand.

In actual fact the delivery rate is steadily being raised, and at the moment two aircraft per week are leaving the bustling Vickers factories at Hurn and Weybridge. Last week *Flight* counted 40 Viscounts in the production pipeline, not including scores of large fuselage and other components in the tributary lines. Again we mused upon the industry's ability—given the orders—to organize production in the grand manner to fulfil them.

Weybridge's twin 1,200-ft assembly halls, newly extended, already contain mature assembly lines—one of them filled with 802s for B.E.A., the third of which is almost ready to emerge from the hangar door. Included on the parallel line were two handsomely styled and nearly completed 700s for Hunting-Clan, and the special aircraft for the U.S. Hughes Tool Co. These will be the last 700s built at Weybridge. Indeed, it is now possible to discern the future pattern of Viscount production: 800s at Weybridge and 700s at Hurn.

At the latter plant, 100 miles to the south-west, the Capital line —a self-contained assembly unit concentrating on an identical run of 745Ds—has already worked its way through nearly two-thirds of the U.S. operator's order for 75 (delivery will be completed by next summer). The parallel line inevitably does not move at the same pace as its Capital neighbour, concerned as it is with assorted orders for aircraft with different detail differences. Included on this line at the time of writing were the second and third executive aircraft for the U.S. Steel Corp. (the first was on flight-test, with special attention being paid to the new 540 U.S. gal long-range belly tank), to be delivered unfurnished but with nose-radar provision. Tracing the production flow back towards its source we noted in the nearby fuselage assembly shop well advanced components clearly labelled 806—forerunner of the new breed of faster Viscount. The first aircraft should be flying by mid-1957.

—AND A THREE-DIMENSIONAL VANGUARD

THE fact that the Vanguard is a descendant of the Viscount has led to misconceptions about its size. We still hear it described as a "bigger Viscount," yet even those who appreciate the distinction between the two aircraft would, we believe, be unable to contain their surprise on beholding the new full-scale Vanguard mock-up.

The Vanguard's great size is the immediate and lasting impression formed upon entering—as we did a few days ago—Vickers' mock-up department at Weybridge. The elaborate wooden dummy Vanguard there really brings to three-dimensional life the drawings of the design office. The advanced state of design is at once evident from the amount of detail equipment and systems circuits already installed (rear spar components, for example). The interior is of particular interest: its great volume enabled us to visualize the remarkable fact that the Vanguard can accommodate up to 130 tourist passengers. This sort of capacity really promises to alleviate the problem of how to make money out of high-density short-haul operations.

The second most striking impression is the great capacity of the two underfloor freight holds—the unique feature of the Vanguard, and the answer to the airlines' problem of how to carry full capacity when only a few of the passenger seats are filled. The floors of these holds are at waist-height (the small ground-clearance of the fuselage being made possible by the mid-wing arrangement) and access is from the starboard side—a deliberate separation from the port-side passenger doors.

We hope to publish photographs of the Vanguard mock-up, which is undoubtedly the most elaborate yet built in this country, in an early issue.

Although the two are of different families, there is a striking likeness between the Vickers-Armstrongs Viscount and the de Havilland Heron. Here—photographed early one morning last week at Hurn—is the 46th Capital Viscount taxying out for a test flight, followed by the D.H. Heron employed by Vickers on regular communications between the company's factories.

CIVIL AVIATION . . .

FIRST OF BRITAIN'S SEVEN SEAS

SLEEK and "new pin" in its B.O.A.C. livery, the first of the Corporation's ten Douglas DC-7Cs was greeted at London Airport on the last day of October by Mr. Keith Granville, B.O.A.C.'s sales director. Because of a S.E. headwind component unusual over the North Atlantic (at times reaching 100 m.p.h.), G-AOIA had broken the journey from San Francisco to London at Montreal, which it reached in 7 hr 38 min. The 3,370 st. m. from Montreal to London were covered in 10 hr 48 min at a ground speed of 320 m.p.h. and the aircraft was chocked at 1.55 p.m.

The opportune arrival of B.O.A.C.'s first DC-7C—right on time and soon to be in service—was welcomed by the Corporation as an alleviation of the equipment troubles with which they have been persistently dogged. The wish frequently expressed on London Airport's tarmac was that this could have been a British jet or a British turboprop—proved for service as was the efficient newcomer from Santa Monica—and delivered (as we remarked in *Flight* of October 26) comfortably within the contract date. But whatever regrets there may have been for the necessity of placing an "insurance policy" order in the U.S., the choice of aircraft was acclaimed by Captain Gordon Store. "A marvellous aeroplane," was his summary of the B.O.A.C. crew's delivery and training-flight experiences.

Had the customary easterly transatlantic winds prevailed, it had been intended to fly the great circle distance of 3,700 n.m. from San Francisco to London non-stop. As the delivery date approached, several flight plans—typically overflying Goose Bay on a 4,900 n.m. stage occupying between 16 and 17 hours—were studied by the B.O.A.C. crews. With the delivery of the first DC-7C, crew training in the U.S. (which began in April) has been completed except for some flight-simulator training in New York.

The aircraft was delivered with a 60-seat first-class layout divided into three compartments. Bulkheads trimmed with natural wood panelling divide the cabin into a forward compartment for eight, a 36-seat centre compartment with fold-away overhead bunks (presenting a slightly claustrophobic effect) and a rear compartment for 16. Although the interior colour scheme is predominantly blue and white, gay curtains in a zig-zag pattern of pink and white avoid any colour monotony. The normal crew consists of the captain, a first and second officer, navigating and engineer officers and a cabin crew of four. Among the standard equipment which the flight deck crew have available is search radar, the Sperry integrated flight system, and the Selcal "selected-call" system.

A Heron of Dragon Airways at Schiphol Airport. These independent operators achieved a utilization of over 1,200 hr from the aircraft in the first year of Heron operations.

A. CDRE. POWELL

TALKING to Mr. Eoin C. Mekie, chairman of British Aviation Services, about the inadvertent omission of the word "deputy" in a reference to an appointment in the company last week, we learned that—while he rejoiced that A.V-M. S. D. McDonald had accepted the position of deputy managing director—he confidently expected that A. Cdre. G. J. Powell would continue as managing director until retirement age a good number of years hence—and if possible after that as well.

A. Cdre. Powell was founder of British Aviation Services and has been a director since its inception in 1946. The company is the parent of Air Kruise, Aquila, Britavia, Manx and Silver City.

BREVITIES

SERIOUS disclocation of air services to and *via* the Middle East has occurred as a result of the Egyptian crisis. The Air Ministry has advised all transport aircraft to avoid an area within a line stretching north from the Gulf of Sollum on the North African coast to a point about 50 miles south of Crete; east along a line parallel with and 200 miles north of the Egyptian coast; and north again to Turkish territorial limits.

* * *

California Eastern Aviation, Inc., is reported to be seriously interested in the purchase of Convair 880 jet airliners.

* * *

Following the I.A.T.A. traffic conference at Cannes in June, emigrant air fares on scheduled airline services took effect on November 1.

* * *

An exchange of ideas between Sud Est, makers of the Caravelle, and a group of Soviet engineers took place in Paris recently. A group of French technicians has been invited to visit Moscow early next year.

* * *

A lecture on London Airport was given to the Royal Aeronautical Society by Air Marshal Sir John D'Albiac on November 6. We hope to summarize the lecture and discussion in a future issue.

* * *

Our Australian correspondent reports that the control of Butler Air Transport is the subject of a dispute between Mr. Arthur Butler, the managing director, and Sir Ivan Holyman of A.N.A., who hold the majority of the shares.

* * *

C.A.A. is reported to have been asked to supervise the civil evaluation of the Lockheed GL-108 (civil version of the C-130) and the GL-135—Lockheed's contender in the U.S.A.F.'s light jet transport competition. Other entries in this competition will be the Fairchild M185F and a new Convair project.

Mr. J. Banfield has been appointed civil air attaché in West Germany as from November 12. Headquarters are in Bonn.

* * *

A £1m terminal building is under construction at Gander. It should be completed by the winter of 1957-58.

* * *

A landing and transit rights agreement between West Germany and Brazil was concluded on October 20 but has yet to be signed.

* * *

Ivan Wassiliwitsj Smirnoff—famous for his Fokker F.XVIII flight in December 1933 from Amsterdam to Djakarta and back in 100½ hours each way—died on October 28.

* * *

The Boeing 707 was recently flown by the deputy chief test pilot of Vickers-Armstrongs, Mr. E. B. Trubshaw. He made two flights at Seattle totalling four hours.

* * *

Intourist has announced that a new Russian airline is due to link Moscow and Cairo, with stops at Bucharest, Sofia and Athens, towards the end of the year.

* * *

The Britannia was demonstrated in Rome on October 25 to the Italian director of civil aviation, the deputy chief of staff of the Italian Air Force, and the vice-president of Fiat.

* * *

Sabena's first S-58 helicopter landed at Eindhoven on October 22. Tilburg, in Southern Holland, has a helicopter under construction for the airline's expanding rotary-wing operations.

* * *

The Consolidated Diesel Electric Corporation has devised "wheel-mover units" to be attached to each main landing gear of big transport aircraft. Each unit—which can be quickly fitted by one operator—is driven hydraulically from a mobile power unit and enables the pilot to taxi without engine power.

NUCLEAR POWER FOR AIRCRAFT

A Lecture by the Chief Executive of the Hawker Siddeley Nuclear Power Co.

ON Tuesday, October 30, a forward-looking talk with the above title was given to the Graduates and Students Section of the Royal Aeronautical Society by Mr. E. P. Hawthorne, B.A., A.F.R.Ae.S., director and chief executive of Hawker Siddeley Nuclear Power Co., Ltd. Mr. Hawthorne began by briefly describing the principles of the thermal reactor and the fast reactor. The former depended on the neutrons arising from fission being slowed by a moderator, after which the slow neutrons were captured by further uranium-235 atoms, thus sustaining the chain reaction. This type of reactor required a much lower proportion of the fissile uranium-235 isotope than did the fast reactor, but was considerably more bulky. A North American Aviation proposal for a 75 MW reactor was approximately 17ft in diameter and 14ft high.

A fast reactor used the fast neutrons to produce further fission without the slowing-down action of the moderator. This type of reactor required a much higher proportion of U-235 fissile isotope in the fuel. It did, however, have the great advantage of small bulk, the reactor core for a 60 MW unit being only 2ft in diameter and 2ft long. This small bulk gave rise to the need for very high heat-extraction efficiency and also to more critical control-characteristics. The Argonne Laboratory in America had proposed a fast reactor with a power output of 28 MW/cu ft core. The reactor and all its associated controls and pumps were, for safety reasons, contained in a tank 10ft in diameter and 13ft high.

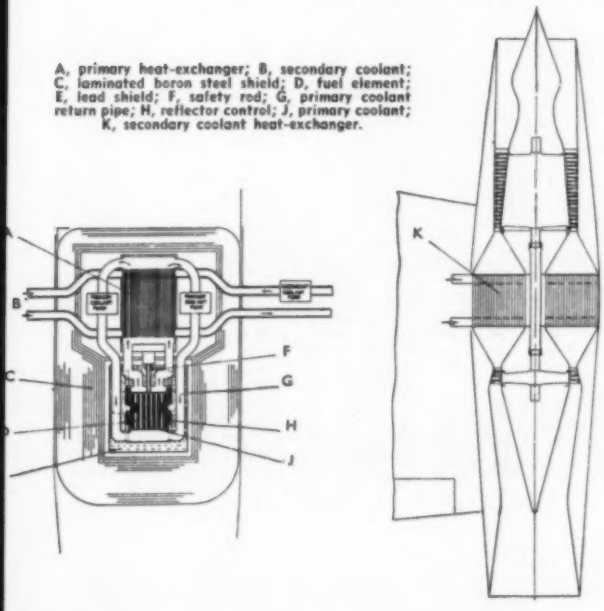
Heat could be extracted by air, gas or liquid metal. For the fast reactor the very high design-efficiency made a liquid-metal system necessary.

In aircraft propulsion the main problem was that of providing adequate shielding. Gamma-particles could be absorbed only by interaction with electrons, which demanded a material with a high mass such as lead or iron. Conversely, neutron capture was best achieved by a material of relatively low mass, such as boron or lithium. Aircraft shielding would possibly consist of a considerable thickness of lead followed by layers of the lighter material interspersed with iron. Important weight-reductions could be obtained by using partial shielding, i.e., by shielding only that part of the reactor which faced the crew compartment.

The lecturer thought that it should be possible to conceive an aircraft powered by a fast reactor with solid fuel elements. For an aircraft with a desired performance of Mach 2.5 at 60,000ft, 250 MW (335,000 h.p.) was required, obtained from a reactor of 20in core diameter with a rating of 50 MW/cu ft core. The heat-exchange would be by liquid sodium (with an intermediate heat-exchange to restrict active sodium to shielded areas) which would be passed through a flat-plate heat-exchanger (2ft long) in the "combustion chamber" of an otherwise normal turbojet (see illustrations on this page and page 743). The outlet temperature of the reactor heat-exchange fluid would be around 750-800 deg C, compared with about 500 deg C for present reactors. This rise in temperature gave a more efficient cycle with a decrease in reactor size and aircraft drag.

Schematic arrangement of a metal-cooled reactor, and engine, in an aircraft—an illustration from Mr. Hawthorne's paper.

A, primary heat-exchanger; B, secondary coolant; C, laminated boron steel shield; D, fuel element; E, lead shield; F, safety rod; G, primary coolant return pipe; H, reflector control; J, primary coolant; K, secondary coolant heat-exchanger.



An aircraft of this size would weigh a minimum of 150,000 lb and might well weigh twice as much; its payload would be of the order of 10,000 lb. The reactor weight would be between 30,000 and 35,000 lb and the heat-exchanger would weigh about 1,000 lb per 1,000 lb of thrust. Because of the great weight and mass of the reactor it would probably have to be mounted on or near the c.g.

At take-off considerably higher thrust was required than in cruising flight. If the reactor were designed for the cruise condition, the take-off would require either a temperature overload (which would be difficult to achieve) or the provision of auxiliary thrust. It seemed that use of the reactor was the best solution, but this in turn brought up the problem of the accident case. Reactors had an immediate residual energy level of six per cent of the operating level prior to cut-off. If an atomic-powered aircraft suffered a take-off accident when the reactor was operating at maximum power, the residual energy level might prove a serious hazard.

Speaking of the accident problem in general, Mr. Hawthorne said that the result of a reactor going out of control was the vaporization of the liquids and solids it contained. If these were discharged to atmosphere a large part of the surrounding country would be seriously contaminated. Similar considerations applied in the crash case, when rupture of the reactor would result in wide-scale dispersal of highly radioactive fission products. Even if rupture of the reactor could be avoided there remained the problem of the six per cent residual energy level, for which there was no obvious solution at present.

One suggested way of avoiding these risks was to use atomic-powered aircraft as remotely controlled tugs for conventionally powered machines. These tugs would always remain at high altitude, the towed aircraft taking off and landing under their own power and joining and leaving the tug near the departure and destination airfields. Another suggested application in the aircraft field was the "nuclear rocket" engine. This envisaged a reactor made from porous ceramic, which would have one of the greatest surface/volume ratios obtainable, operating at temperatures around 3,000 deg C. The fuel, probably hydrogen, would be pumped over the hot reactor surface. A disadvantage was that a fuel had still to be carried.

Summing up, the speaker concluded that the advantage of the nuclear-powered aircraft was unlimited range, and that if it was decided that such an aircraft was required he thought that it could be built. The magnitude of the task, however, could perhaps be judged from the film of the building of Calder Hall power station which he was about to show. This power station had a rating of only *one-third* of the proposed aircraft powerplant; he would leave it to the meeting to decide how complex were the engineering problems involved.

In the subsequent discussion many interesting points were made. The lecturer considered that the safety aspects prevented nuclear power being used in any but military aircraft at the present time. The fuel economy of a nuclear-powered aircraft appeared to be better than one using kerosine. In a different vein, he thought that a closed-cycle propeller-turbine was also quite practicable; it depended on what one wanted the aircraft to do.

Another proposal was to put the fuel in the "combustion chambers" themselves, which Mr. Hawthorne considered feasible provided there was sufficient heat-exchange efficiency. At the present time there appeared to be only one forseeable way of using the energy from nuclear fission and that was by heat-exchange; the prospects of using nuclear power in conjunction with such devices as electro-static lift were too remote to be considered. The response to rapid throttle-movements was a tricky subject and might have to be solved by using a "heat dump."

On the subject of the design effort necessary to construct a nuclear-powered aircraft, Mr. Hawthorne believed that this would be very large indeed. Maintenance requirements would probably be less than on conventional aircraft, since there were no moving parts. There might be some problem in keeping the sodium liquid between flights, but this was not too difficult.

Finally, aircraft structural designers were relieved to hear that the level of radioactivity would not be high enough to cause appreciable material damage during the expected life of the aircraft. On the other hand, the proposal that the powerplant life would exceed the airframe life and that the "nuclear engine" would be removed from an old airframe design and installed in a new design was one of the many revolutionary ideas put forward during a most stimulating evening.

SERVICE AVIATION

Royal Air Force and Fleet Air Arm News

Senior Naval Appointments

THE Admiralty has announced that the Queen has approved the appointment of Vice-Admiral Sir Caspar John to be a Lord Commissioner of the Admiralty and Vice-Chief of Naval Staff with effect from next May. Sir Caspar, who is at present Flag Officer Air (Home), has long been associated with Naval aviation and was previously Deputy Controller of Aircraft Production at the Ministry of Supply.

Succeeding Sir Caspar as Flag Officer Air (Home) is Vice-Admiral W. T. Couchman. At present Deputy Controller of Supplies (Air) at M.o.S., he has been associated with Naval Aviation since 1943. In 1954 he became the first officer to hold the appointment of Flag Officer Aircraft Carriers.

Rear Admiral A. S. Bolt has been appointed Deputy Controller of Aircraft at M.o.S. in succession to Vice-Admiral Couchman. During the Korean War he commanded H.M.S. *Theseus* and has since served as Director of the Admiralty Air Warfare Division. His present post is Chief Staff Officer to the Flag Officer Air (Home).

Aid to Hungary

HASTINGS and Valettas of Transport Command were responsible for the delivery last week of the £25,000-worth of food and medical supplies given to Hungary by the British Government. Following the announcement of the gift, aircrew at R.A.F. stations Dishforth, Benson and Abingdon received an urgent call at 0300 hr. By 0700 the first of the 15 aircraft from Britain were airborne for Wildenrath, where they were joined by six aircraft of 2nd T.A.F. Here the supplies were loaded and by noon the first aircraft was on its way to Vienna. A total of 72 tons was carried.

Ark Royal Recommissioned

AT a ceremony last week, the aircraft carrier H.M.S. *Ark Royal*, the Navy's largest operational vessel, was recommissioned at Plymouth following a refit. The Commanding Officer, Capt. F. H. E. Hopkins, welcomed Admiral Sir Mark Pizey, C-in-C. Plymouth and Admiral Sir John Eccles, C-in-C. Home Fleet.

A major part of the refit concerned the improvement of the operations room for the control of operations of modern warfare. New radar equipment of increased accuracy has been fitted.

The closed-circuit television system has also been improved. B.B.C. programmes are relayed while the ship is in range, and films, lectures and live shows are televised when she is far out at sea. The system is also used for addresses by the Commanding Officer, and for the briefing of aircrews.

Malcolm Club in England

THE first Malcolm Club to be established at an R.A.F. airfield in England is to be opened today at R.A.F. Wittering by Marshal of the Royal Air Force Lord Tedder. Thirteen years ago Lord Tedder, then Air C-in-C. Mediterranean Air Command, opened the first "front line" Malcolm Club at Algiers.

Malcolm Clubs were asked to provide a second mobile welfare facility—catering for personnel on night duty—at Wittering early last year. They were later requested to build a club on the station. The organization is named after the first R.A.F. V.C. of the North African campaign, W/C. H. Malcolm. There are now over a score of Malcolm Clubs in Germany, France and the Far East.

During recent training in the Southern Alps, New Zealand, for the Trans-Antarctic Expedition, the special Beaver which will be taken was used to drop 50- and 12-gallon fuel drums from wing-racks into compacted snow from 50ft at 120 m.p.h. Sir Edmund Hillary, Mr. Bob Miller and S/L. Claydon, R.N.Z.A.F., are here seen loading a large drum. The Beaver carries a Sarah homer to be used for finding ground parties to be supplied by air.

R.A.A.F Olympics

FOUR members of the R.A.A.F. have been selected to represent Australia in the Olympic Games at Melbourne. F/L. B. T. Oliver, serving with No. 5 Airfield Construction Squadron at Darwin, will compete in the hop, step and jump. F/O. R. K. Gosper, serving at Ballarat, has been selected for the 400-metre race and the 400-metre relay. F/O. J. D. Wolfensohn and Cdt. Off. M. S. Diamond, both members of the Sydney University Squadron, will join the *épée* team. They are members of the University Fencing Club.

Wg/O. D. Carter, who competed in the 1936 Olympic Games in Berlin, has been appointed the women's manager with the Australian team. She was also an international hockey player.

So Clean You Could . . .

HIGH standards were achieved by the finalists in the competition for the 1956 Jolliffe Trophy R.A.F. Dining Hall Competition. Winners were R.A.F. Lyneham, with R.A.F. Driffield close runners-up. Instituted in 1941 by the late Capt. R. L. Jolliffe, the trophy is awarded annually to the station having the cleanest and most pleasant dining hall.

Padgate to Close

THE famous R.A.F. reception centre at Padgate, Lancs, through which 60 per cent of the post-war intake of National Servicemen has entered the R.A.F., is to be closed early next year.

Royal Air Force Appointments

THE following continues the list of Royal Air Force appointments announced by the Air Ministry:—

W/C. F. E. Frayn, M.B.E., to H.Q., SHAPE, for staff duties; W/C. L. H. Greenman to Air Ministry for duty in the department of the Chief of the Air Staff (with the acting rank of Group Captain); W/C. W. H. Jones, to Headquarters Flying Training Command for technical staff duties; W/C. A. C. Kerr to R.A.F. Stradishall, for technical duties; W/C. A. J. Mott to H.Q. Coastal Command for technical staff duties; W/C. A. G. Pell to R.A.F. Jurby, for administrative duties; W/C. E. G. Rands to R.A.F. Cranwell, Lincs, for administrative duties; Acting W/C. H. Simmons to H.Q., M.E.A.F. Command, for administrative staff duties, retaining his acting rank of Wing Commander; W/C. F. M. Thomas to No. 3 Radio School, Compton Bassett, for technical duties; W/C. J. Scott-Hepburn to R.A.F. St. Athan, for administrative duties; W/C. H. E. Kelsey to R.A.F. Halton, for administrative duties; W/C. R. D. G. White to Air Ministry, for duty in the department of the Air Member for Supply and Organization; W/C. G. H. Harris to H.Q. Flying Training Command, for administrative staff duties; W/C. W. C. Armstrong to R.A.F. Seletar (F.E.A.F.) for administrative duties; W/C. A. B. Jones, M.B.E., A.F.C., to R.A.F. Halton, for administrative duties; W/C. J. Yeadon to R.A.F. Catterick, for administrative duties; W/C. J. N. C. Law to Air Ministry for duty in the department of the Air Member for Supply and Organization (with acting rank of Group Captain); W/C. M. L. Gaine, D.S.O., A.F.C., to R.A.F. Yatesbury, to command (with acting rank of Group Captain); W/C. D. F. Hyland-Smith, D.F.C., A.F.C., to R.A.F. Benson, as Officer Commanding the Queen's Flight; W/C. C. E. R. Tait, O.B.E., D.F.C., to R.A.F. Worksop, for administrative duties; W/C. A. M. K. Phillips, to H.Q., Flying Training Command, for administrative staff duties; W/C. R. L. Wade, D.F.C., to R.A.F. Staff College, Bracknell, for directing staff duties; W/C. E. J. Holloway, D.F.C., to R.A.F. Wyton, for flying duties; W/C. P. W. Helmore, D.F.C., A.F.C., to R.A.F. Binbrook, for flying duties; W/C. F. G. Woolley, D.F.C., to R.A.F. Staff College, Bracknell, for directing staff duties; W/C. I. R. Campbell, A.F.C., to R.A.F. Sandwich, to command; W/C. R. C. E. Scott, M.V.O., A.F.C., to R.A.F. Coningsby, to command; W/C. V. F. Wallace to Air Ministry, for duty in the department of the Air Member for Supply and Organization; W/C. J. P. Pryer to R.A.F. Tangmere.

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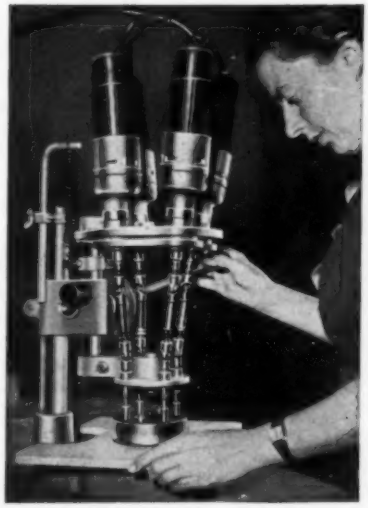

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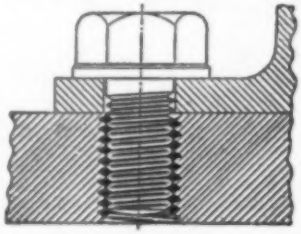

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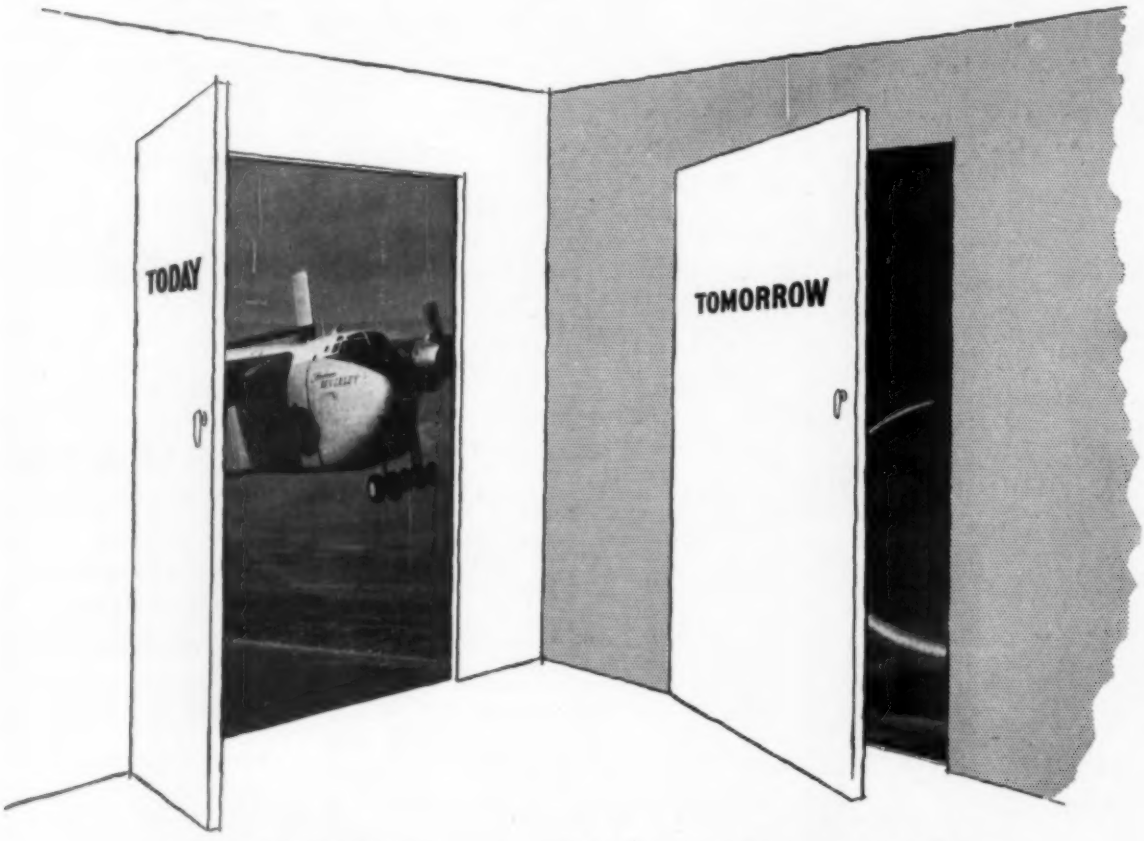

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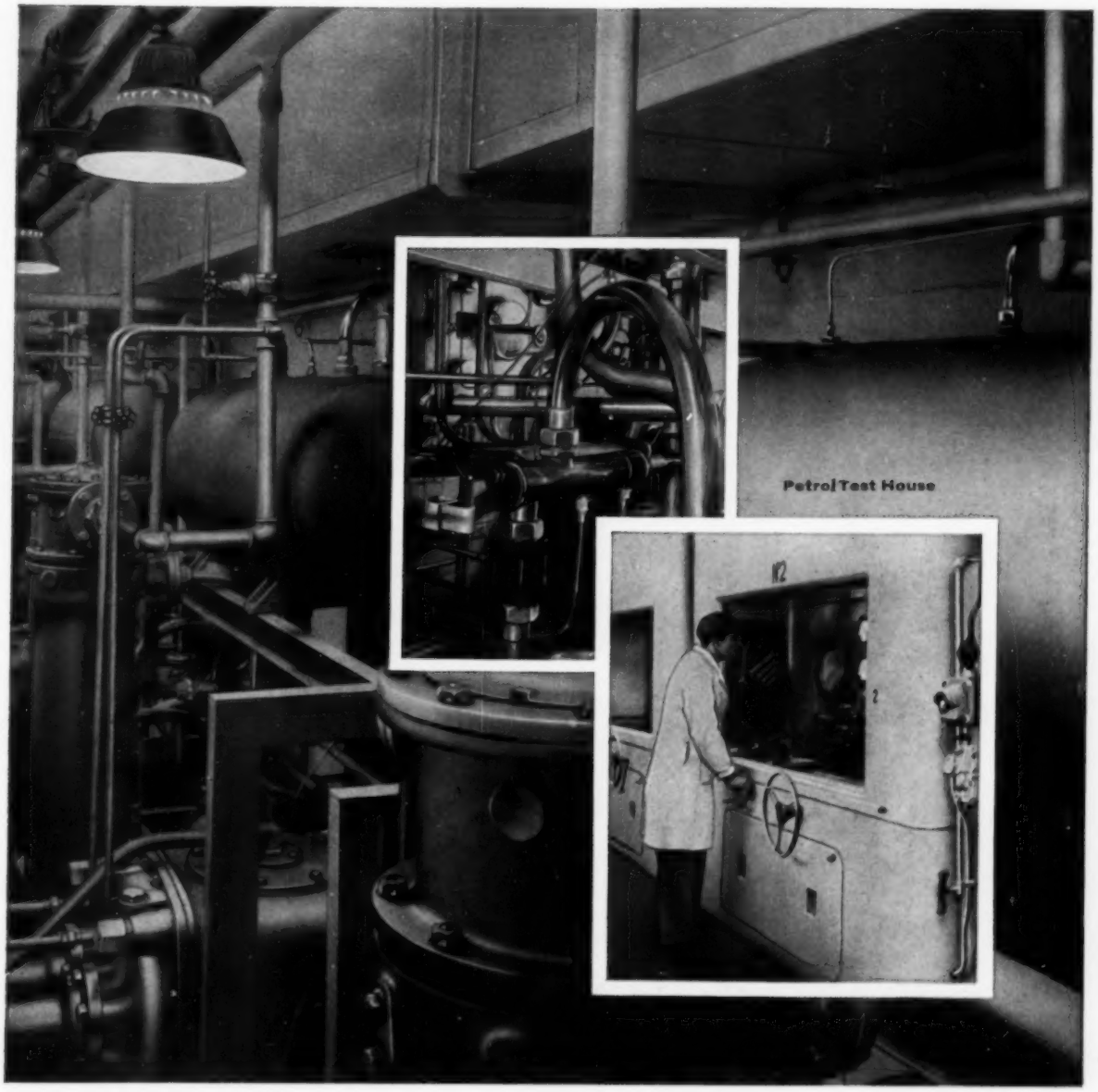

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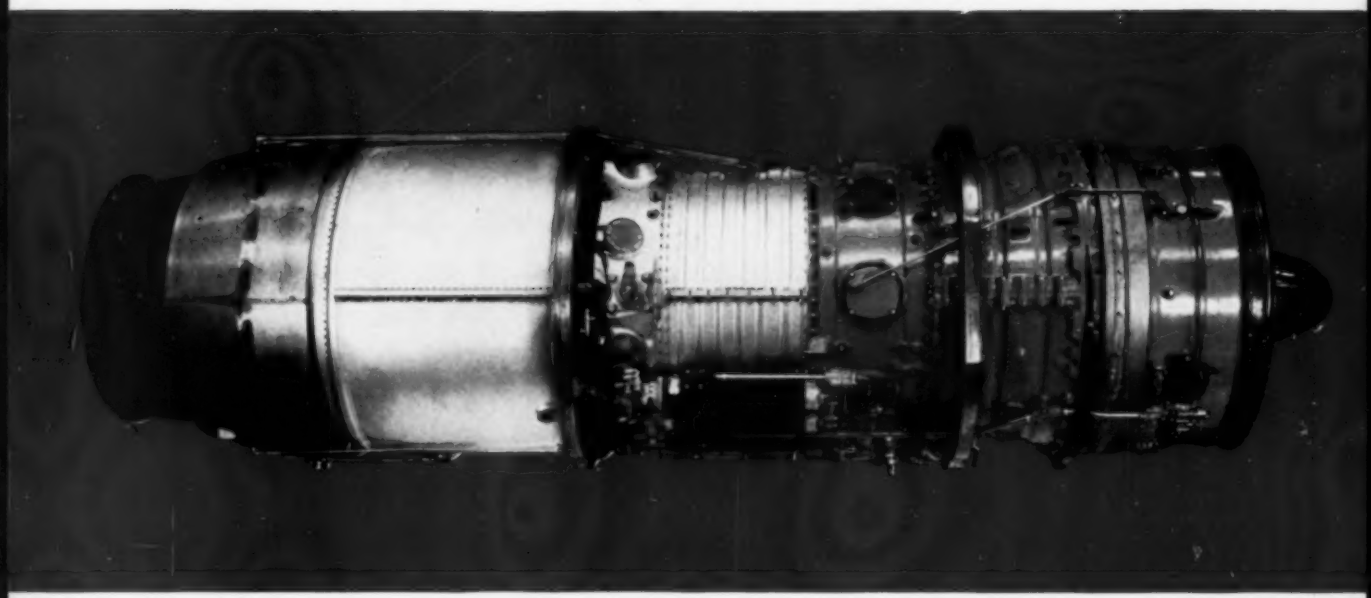

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